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SUPERIORITY OF THE FEMALE BRAIN • X-RAY HOLOGRAMS • ROGER SPERRY ON RELIGION, CONSCIOUSNESS, AND THE SPLIT BRAIN • SAPIENS RISING: MAN IN 1,000,000 A.D.

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CONTENTS

			PAGE
GENIUS SPERM BANK	First Word	Afton Blake	6
OMNIBUS	Contributors		10
COMMUNICATIONS	Correspondence		14
FORUM	Dialogue		16
EARTH	Environment	Ben Barber	18
LIFE	Biomedicine	Thomas A. Bass	20
SPACE	Comment	Richard C. Hoagland	24
SUPERIORITY OF THE FEMALE BRAIN	Mind	Carol Johmann	26
ARTIFICIAL INTELLIGENCE	Computers	Michael Edelhart	28
FILM	The Arts	Brian McKernan	32
CONTINUUM	Data Bank		35
ANIMAL FEMINISM	Article		44
X-RAY HOLOGRAMS	Article	Richard Wolkomir	50
WIRED	Fiction	David Bischoff	56
ROGER SPERRY	Interview	Yvonne Baskin	68
UNEASY PASSIONS	Pictorial	Gottfried Helnwein	76
SAPIENS RISING: MAN—1,000,000 A.D.	Article	Pamela Weintraub	86
ANTIMATTER	UFOs, etc.		91
EXPLORATIONS	Travel	Delta Willis	108
CREDITS			110
BREAKTHROUGHS	Technology	Michael Edelhart	122
TENSILE TENTS	Phenomena	Anthony Wolff	124
THE MARS-ROCK MYSTERY SOLVED	Stars	Charles Koltz	126
GAMES	Diversions	Scot Morris	128
DENSA: MENSA FOR THE DUMB	Last Word	Nigel ffooks	130

French-born Michel Tcherevkoff presents a visual interpretation of the ideational process. His striking, surreal images bear his distinctive signature, and his inimitable use of special effects has made him one of New York's foremost advertising photographers.

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FIRST WORD

By Afton Blake

"The first few sperm banks assured me only that I could choose the father's race and religion. My quest then led me to the "Nobel sperm bank" in California."

I am a woman who has always known that she would have a child. My thirties rushed by me in a whirl of professional involvements; I was finishing graduate school, building a practice, acquiring economic stability, as well as experiencing emotional and spiritual growth.

In 1981 I realized I was approaching forty without a relationship or a child. Yet, the time appeared right in all respects to have a baby. A relationship seemed superfluous. How would I create my family? I contemplated several options: inviting a friend whom I loved and respected to be a father and coparent; a voyage around the world to befriend a mysterious stranger I would never see again, an option that presumed that such a man would be capable of insemination on demand; placing a personal ad in *The New York Review of Books*; or a sperm bank. After careful deliberation, I chose the sperm bank as appropriate for my own needs. I would remain uncommitted—free to continue the search for that ideal relationship and free to instill my own parenting values in my child without conflict from a spouse.

But which sperm bank? I began to investigate the alternatives. It was paramount that I know a great deal about the father's background, and that he be a man I could admire and respect. His emotional, intellectual, spiritual, and physical well-being was important to me.

Unfortunately, the first few sperm banks assured me only that I could choose the father's race and religion, neither of which seemed relevant to me, and that the donor would most likely be a medical student. I was uncomfortable with so nebulous a profile. My quest then led me to the Repository for Germinal Choice, or the "Nobel sperm bank," as it is affectionately called after the Nobel laureates who were the first donors in the Seventies. Located in Escondido, California, and founded by Herman Muller, the repository believes that a woman has the right to select genetic qualities for her offspring and is firmly committed to making such choices available.

I was able to find a "father" for my child who was unquestionably a man I would value as a vital human being, a man who was intelligent, creative, healthy, attractive, cultured, and psychologically well-balanced, as evidenced by his family history. The donor also shared many of my interests and values. I felt comfortable that this person could contribute the genetic material that I believed was needed to invite a soul into the world.

The rest was up to me. Nurturance, I believe, probably accounts for about 50 percent of what a person becomes. My son, Doron, is thus about 75 percent my responsibility—25 percent my genes and 50 percent the environment I've created for him, if you accept my child-rearing equation.

Once I was certain of my choice, the artificial-insemination process was a joyous ritual, made so largely through the encouragement of my friends and family and the staff of the Nobel sperm bank. For ten successive months I inseminated myself with the donor's frozen sperm before my son was conceived.

I did not get the sense of being a pioneer until the media descended on me in my eighth month of pregnancy. I had not comprehended that I was different. Now I understand the uniqueness of my venture and the symbol I have become to other single professional women—and men, too—who find themselves alone in their late thirties or forties without the child they desire. No longer does the deliberate creation of a single-parent family remain a fantasy.

Doron (the name is from the Greek and Hebrew words for *gift*) will celebrate his first birthday this month. He is more than I thought I could ever have. Through his coming, I know a deeper love. I am more awed by life. I have a greater investment in the future of our planet than I could have known was possible. For the first time in my life, I do not feel I am missing something. And there are positive aspects of such a relationship exclusive to the single parent. The dyadic intimacy between mother and child would be difficult to duplicate in the marriage triad. The symbiosis of the first 18 months of life, so essential for psychological health, can immerse one completely.

My choice of bringing Doron into the world in this deliberate manner is an implicit statement, one that raises moral and ethical considerations. I feel that having a child in this age is no longer a right but a privilege that demands grave considerations. An unborn child should be guaranteed the best genetic material. Potential "quality of life" must be assessed before a soul is invited in.

Ideally, an individual, after experiencing a well-nourished childhood, should be able to emerge as an adult who can give more than he takes from humanity. The likes of Churchill and Gandhi must be more abundant if the imbroglio that our planet has fallen into is to be corrected. Individuals *invited* into the world at this time—and each birth should be meditated on as if it were a careful invitation—must have a capacity for broad vision. Deliberate genetic selection is one way of accomplishing this. The family, as we have known it throughout history, will remain as one alternative. Single parenthood, when all the economic and emotional considerations have been understood, is now another option.

Would I do it the same way again? In another couple of years, I will contemplate whether or not I should invite another person into this world. ∞

Afton Blake, a Los Angeles psychologist, is the second woman to deliver a baby through the so-called Nobel sperm bank.

OMNIBUS

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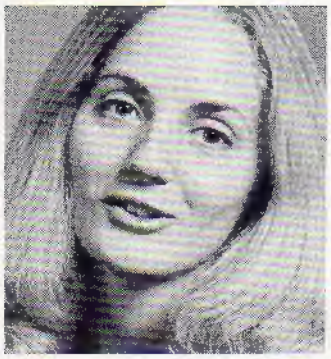
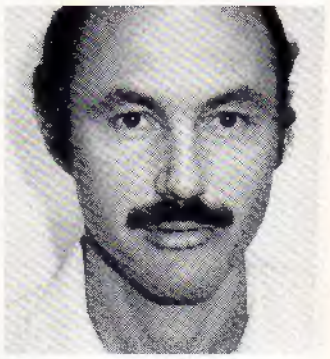
WOLKOMIR



BASKIN



BARBER

The giant atom smashers known as synchrotrons have long enabled physicists to scrutinize quarks, bosons, and other subatomic oddities. Now, a spinoff of this technology promises to become one of the hottest new scientific tools for probing everything from proteins in cell membranes to the chemistry of the earth's molten core. The idea is to harness the powerful X rays generated by particles as they rush around the circular synchrotron. This vast energy, once considered pure waste, is being tapped for all sorts of experiments that were once impossible. For example, one scientist used the bursts of X rays as a superhigh-speed strobe. In 100 billionths of a second he was able to record the effects of a laser etching a crystal. According to *Omni* contributor *Richard Wolkomir*, who traveled to Cornell University to see this synchrotron radiation in action, the X rays coming off the atom smasher were impressive. "I saw an X-ray beam burn a hole straight through a thick slab of lead," he recalls. At the Cornell High Energy Synchrotron Source (CHESS), Wolkomir inspected the lead "telephone booths," where biochemists, metallurgists, and other scientists expose materials to the sizzling radiation and study the results. "The lab has all sorts of safeguards to protect personnel from accidental exposure to those beams, but it's still a spooky feeling down in that underground installation," Wolkomir says. Turn to page 50 for his report on the world's most powerful X ray.

Today the phrase *split brain* is almost a cliché. But two decades ago, when neuroscientist Roger Sperry tested and confirmed his theory that each hemisphere of the brain has "a mind of its own," such a notion was considered heretical. In recognition of his pioneering investigation into the dual nature of human consciousness, Sperry shared the 1981 Nobel Prize in medicine and physiology. An extremely reclusive man, Sperry has shied away from speaking to general audiences in the past. "He doesn't do interviews," his secretary of 25 years told *Omni* writer *Yvonne Baskin* when she contacted his office in May 1982. To the surprise of both parties, however, the request was granted. Explains Baskin, "*Omni*'s inquiry came at the right time. Sperry had just completed a book, *Science and Moral Priority*, and was keen to spread the word about what he considers the most far-reaching implications of his research: a revised view of the mind and a proposal for a new world ethic that he believes offers the best hope of keeping man off the endangered species list." This month's Interview (see page 68) is the culmination of an exchange of phone calls, letters, and a series of meetings that spanned almost a year.

Most of us relegate the image of large-brained, slit-mouthed men and women to the pages of science fiction. But a growing number of scientists say that if humans keep evolving according to trends already established, these strange-looking creatures could be the result. Researchers think the driving force behind this change is the process of neoteny—the genetic mechanism by which juvenile traits are retained into adulthood. A million years from now, these theorists add, our "childlike" descendants may have 200-year life spans and brains twice the size of our own. "A few scientists," reports *Omni* editor and writer *Pamela Weintraub*, "say we might eventually alter the genes of neoteny through recombinant-DNA technology, forging the future race ourselves." Her article, "Evolution's Child," starts on page 86.

Our fiction offering is a story by *David Bischoff*, a talented young writer whose novels include *Nightworld* (Del Rey) and *Selkie* (Macmillan). Don't miss "Wired" (page 56), a futuristic tale of a rock-and-roll musician who experiments with a technology that enables him to reach his audience in a way that only he had ever dreamed possible.

"I was in Thailand," says freelance writer *Ben Barber*, "and I saw a mechanized beast, dubbed the Iron Buffalo, whose feet allowed it to navigate through rice paddies." It is one of the many inventions of Prince Mom Teparit, cousin and agricultural expert to the king of Thailand. On page 18 Barber, who has traveled extensively in the Third World, reports on the green revolution that is sweeping Asia.

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AUGUST

LETTERS

COMMUNICATIONS

Robotic Scare

I was glancing at magazines at a newsstand the other day when the cover of the April 1983 issue [The Robot: A Special Edition] stopped me. I immediately recognized the classical allusion.

As I continued to stare, a sense of uncertainty gripped me; it grew into confusion and then anger. Why such a negative response to a painting depicting creation? As much as I appreciated the style, the content worried me. What is *Omni* trying to tell me? Technology is superior to man? Metal men are divine, and human ones are mere clay? What is creating whom? Is this the next wave?

This arrangement of machine giving life to man was not out of necessity but by design, and this beholder found nothing beautiful in the suggestion that robots are better than she. In fact, it scared me.

Karen Alison
Ann Arbor, MI

Scoring Puzzlers

Hey! Wow! Get outta here! Boy, did you push my buttons with the statement made in the April 1983 Games column about the scoring for the "head-scratchers." I am a highly intelligent, analytical, intuitive, verbal counselor type but stupid with games, math, and mind puzzlers. Probably an early childhood trauma, but I wanted to rip up your Games pages with my teeth and stomp on them.

Polly Carter
Santa Rosa Beach, FL

Cheers for Fayetteville

I would like to express my pleasure with the article "Ozark Mountain High" [May 1983]. I feel that William K. Stuckey wrote a fair and informative exposé on the University of Arkansas in Fayetteville.

Recently the University of Arkansas was vilified by some self-proclaimed expert college reviewers who labeled the school an intellectual desert. It should be clear from Stuckey's article that this defamation is far from true.

My only objection is that Stuckey failed to discuss the social environment of Fayetteville. If he were truly seeking enlightenment, he could have walked up the street from Roger's Pool Hall to Restaurant on the Corner and discussed nuclear disarmament or the meaning of life over herb tea and honey.

Robert Bolls
Oxford, MS

As a graduate student at the largest campus of the University of Minnesota, I've seen a representative sample of coeds. And I have yet to see anyone here who looks like one of those "attractive young women with GO TO HELL T-shirts and spray-on jeans" that William K. Stuckey says exist in "incredible numbers" at the University of Arkansas. I wonder if these students really exist in Fayetteville, or if they exist only in Stuckey's mind.

Jennifer Raich
Minneapolis, MN

Thank you, thank you for your article "Ozark Mountain High."

I laughed, then cried, then ached to be in Fayetteville again. The city was once a well-kept secret, but the rest of the world is slipping in (but not out).

In all the world, and I've seen a good deal of it, there is no place as stimulating as Pig Sooey U. and Fayetteville.

Beth Bierwirth
Rosewell, NM

Cloning Musicians

The special April 1983 robotics issue really dazzled my diodes. I am especially excited about the animated figures à la Disney/Westworld. If robot actors could be programmed with artificial intelligence, we'd have perfect androids among us. (I can't wait to marry one!)

Incidentally, robots have already invaded the music industry. I refer to Kraftwerk, the German techno-rock group. The band consists of four humans, a portable studio/computer-synthesizer console, and four robot clones, one for each member of the group. Together, all of Kraftwerk's components constitute the perfect man-machine union.

Melanie Mayfield
Eureka, CA

DIALOGUE

FORUM

In which the readers, editors, and correspondents discuss theories and speculation arising out of Omni. *Readers are encouraged to debate views and pose questions to* Omni, *the scientific community, and the science-fiction establishment. The opinions published are not necessarily those of the editors.*

Frank Herbert on DNA Terrorism

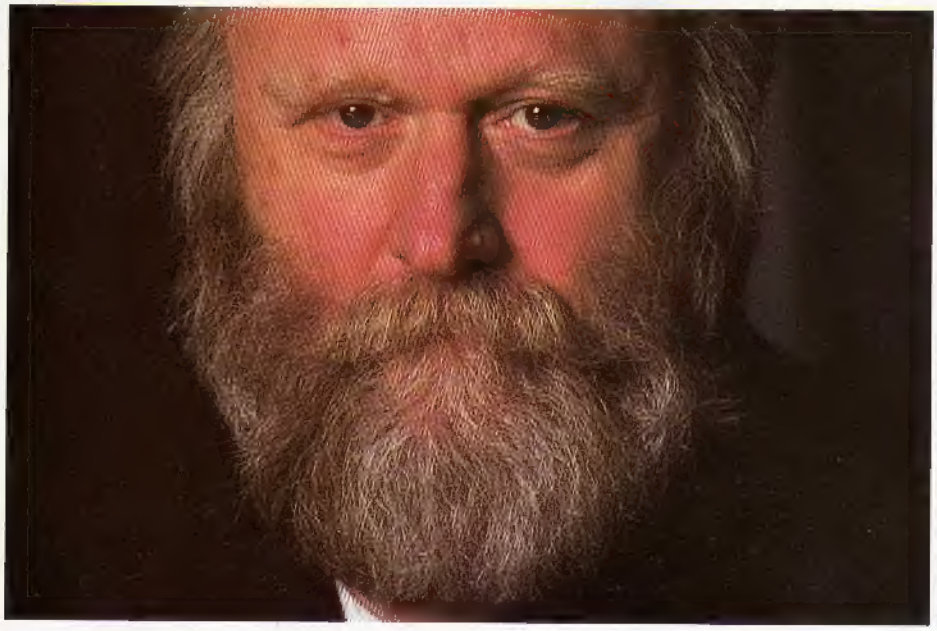
You will understand immediately, I am sure, why Douglas Starr's piece "DNA Wars" [Continuum, November 1982] caught my attention. I covered the same ground researching my novel *The White Plague*, part of which you published in *Omni* [July and August 1982]. As you read this, it should become clear why I wrote this letter only after considerable soul-searching. To publish or not to publish—that is the question. The dangers are obvious, but I am convinced that a broad base of public awareness poses fewer dangers.

What especially interested me in Starr's article was his unquestioning acceptance of the popular mythology about recombinant-DNA costs. His $50 million figure for setting up and running a DNA weapons lab is profoundly misleading. Since even some people at the heart of this work tend to accept such outrageously inflated figures, I think it is time to challenge them.

Most people who make these inflated estimates ignore four extremely important facts about this avenue of biotechnical development. Not considered are ingenuity, surplus sales, thievery, and the intent of the lab.

As examples of ingenuity, a quite serviceable centrifuge can be constructed out of tire-balancing equipment; temperature-controlled cabinets can be improvised from household refrigerators; a kitchen pressure cooker will do nicely as an autoclave; a sonic device for cleaning dentures, available at many drugstores, can be reworked to substitute for much more costly equipment. Furthermore, some of the necessary enzymes can be produced by simple means (one is derived from beans).

Consider what happens in U.S. government sales of surplus equipment. An operational centrifuge was sold at surplus for $17.95. Other lab hardware, some of it usable in a recombinant-DNA project, can be obtained at equally ridiculous prices.



With a little research and a good U.S.-surplus sale, almost anyone can create a DNA lab.

Where criminal activity is concerned, one would have to be living in isolation not to know that consignment thievery is available in every major city in the United States, Western Europe, and the Orient. The rule of thumb for the cost of large items stolen to order in the United States is approximately 10 percent of the market value. This can vary depending on particular problems of breaching plant security, but there is competition where a desired piece of equipment is available in different cities.

This means that you can acquire an electron microscope for about $17,000—no questions asked. And depending on the refinements you specify, the equipment for digital subtraction radiography and computer-linked, X-ray crystallography can be installed for about the same amount.

Now we come to what I believe is the most alarming aspect of these cost estimates—intent. If your intent is only to create something dirty and dangerous, lab costs plummet. Take few personal precautions, ignore dangers to the innocent population, and the low cost of a lab is shocking. Fifty thousand dollars would be generous. Scattershot techniques can be used with minimal equipment. This approach could be called "mix 'em and see what survives." It's not hard to imagine a scenario in which a madman broadcasts the products of his lab without regard for consequences. With a malevolent choice of the subject disease (anthrax, for example), the result would be widespread disaster.

Clearly, this is an insane approach, but did we really need the Tylenol tragedy to make us aware that we share our world with nuts?

High estimates of the costs for this madness are based on the assumption that your lab has a particular scientific goal that can be defined. Let us say you

CONTINUED ON PAGE 107

THE ROYAL RAINMAKER

EARTH

By Ben Barber

Thailand's Royal Rainmaker crash-landed near the town of Surat Thani a few years back, and Communist guerrillas swarmed out of the jungle shouting, "It's a government plane! Let's burn it!"

But the sixty-two-year-old pilot, Prince Mom Teparit, held them off. "Don't you *dare* touch this plane," he said. "It's a rainmaker. Eat these apples, then help me get my machine in the air." The jungle fighters, stunned by the sheer confidence and energy of Mom Teparit, pitched in to fix the single-engine craft.

Prince Mom Rachawong Debriddhi Devakul (Teparit is his widely used nickname) is a living legend in Thailand. Adviser to his cousin, King Bhumibol Adulyadej, and a driving force behind Southeast Asia's agricultural revolution, Teparit has spawned thousands of inventions and developed a method for making rain. Driving across the flat rice bowl of Thailand, one can see his handiwork everywhere: Farmers walk behind Teparit's Iron Buffalo tractor, which is propelled through thick paddy mud with the help of paddle wheels. And the blue tubes of the Teparit Pump bring irrigation to a land beset by drought. Manufactured across Thailand, Indonesia, the Philippines, Laos, and Cambodia, his inventions have helped double and triple crop yield, providing food for the malnourished and easing the drudgery of farm work.

It all began in 1914, Teparit explains, when he was born to diplomat parents at the Thai embassy in Berlin. The mother of the Thai king saw baby Teparit and pronounced: "Everyone in the family is a diplomat. Let this baby study agriculture so he can help the common people."

The royal mandate became reality. Teparit attended prep school in New Hampshire, and he spent summers on a farm, where he "watched as International Harvester tractors replaced big, white horses." Captivated by the mechanical plows, he even tried to drive one himself, smashing it through the wall of a barn. Since his parents were convinced that a Western education was best, Teparit spent the next decade observing the revolution sweeping American farms.

The Iron Buffalo: The tractor invented by Teparit has revolutionized agriculture in Thailand.

Slowly but surely animals were replaced by tractors, irrigation pipes were laid, bugs were banished with pesticides, and crops were made hearty thanks to chemical fertilizer. By the time the prince reached college, American farming had become a science; he spent his undergraduate career mastering everything from agricultural engineering to the subtleties of soil chemistry. In 1940, with a bachelor's degree from the University of Maryland, he vowed to bring the agricultural revolution back home.

Teparit returned to a post at Thailand's Ministry of Agriculture, in Bangkok, and set about estimating the task before him. Wandering through thatched-hut villages and green, quilt-patterned fields, he could see that little had changed over the decades.

Overburdened Thai farmers first planted grains of rice in small, dry plots, waiting a month for them to grow into half-foot-high seedlings. Once the seedlings were ready, farmers used plodding water buffalo to plow nearby fields that were filled with water and surrounded by earthen dikes. Then they transplanted seedlings from the dry field to the wet one, waiting 12 weeks for the crop to mature. When it was time for harvesting, they made holes in the dikes, letting the water flow out and reaping the crop. Finally they repaired the holes and prayed for rain: Without more rain to rewater the paddies, no rice would grow.

This back-breaking process, Teparit knew, was centuries old—and years out of date. The leisurely water buffalo, for instance, were beautiful, but painfully inefficient. Transplanting rice from dry to wet fields ate up thousands of man-hours of labor. And waiting for rain before each new crop meant one planting a year instead of two or three.

Calling upon his American know-how, Teparit realized that "the first step *had* to be the introduction of tractors to pull plows and reapers through water-logged fields." Since American tractors, with their big rubber wheels, couldn't possibly stay afloat, he racked his brains for an alternative. Then he realized the answer

CONTINUED ON PAGE 111

GENETIC COOKBOOK

LIFE

By Thomas A. Bass

Imagine a telephone directory listing every life form. Then think of dialing a number 130,000 digits long. (This might connect you to a herpes virus.) Or picture a cookbook with only four ingredients. Out of such limited fixings, you too could cook up such unsavory dishes as cauliflower mosaic virus or mouse mitochondria, if you follow directions 1,000 steps at a time.

This telephone directory, or cookbook, to life is now being compiled at the Los Alamos National Laboratory, in New Mexico, which recently won a government contract to open a computerized data bank listing all the genetic sequences that have already been decoded. Begun officially in the fall of 1982, the Genetic Sequence Data Bank, or GenBank, as it is called, already includes over a million of the nucleic-acid bases that constitute all or part of the genetic makeup, or genomes, of 175 biological species. GenBank will add another million bases this year as the rate of decoding genetic messages continues to increase more than exponentially.

"Right now we're just scrambling to get all the data," says Walter Goad, the Los Alamos scientist who directs GenBank. "It wouldn't surprise me if we sequenced twenty million bases in the genetic code by the end of our five-year contract."

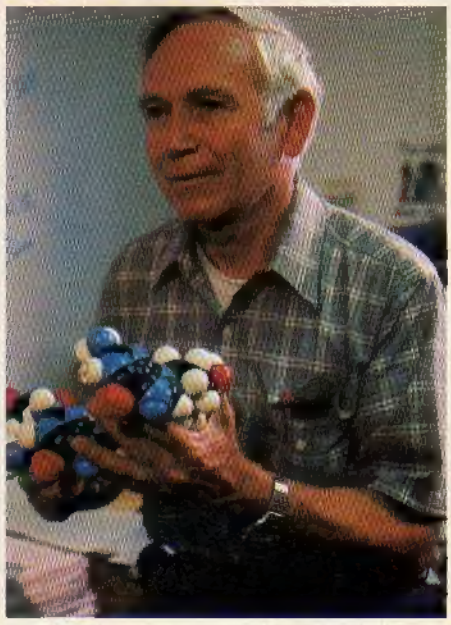
The list of technical advances expected to come out of genetic sequencing is mind boggling: vaccines developed from cloned viruses; special screening tests capable of measuring people's susceptibility to disease; microbes endowed with the ability to churn out petroleum products in the laboratory; edible plants designed to manufacture their own fertilizers; perhaps even ultrafast organic computers capable of building still larger protein machines.

Goad is a handsome man in his fifties who shapes molecules in the air when he talks. His ruddy cheeks and a thatch of white hair make him look like Lorne Greene unhorsed. "This is an exciting place to be," he says, now that he and a dozen staff members find themselves compiling all the world's known information on genetic sequences.

He became a genetic librarian as much by accident as by design. Trained as a particle physicist, Goad for some time had been interested in studying radiation and its effects on genetic mutation. Radiation studies have historically provided the link between Los Alamos, home of the atomic bomb, and basic research in biology, although the mandate of the laboratory has expanded in recent years to include the study of all carcinogens, from auto exhaust to oil shale.

"I don't think there is any doubt that our genetic library will help us to understand what makes something a carcinogen," says Goad. "That's where you have to look to see what's really going on."

As he and other scientists at Los Alamos were getting interested in molecular biology, the revolutionary advances of genetic engineering were just being developed. James Watson and Francis Crick unraveled the double helix 30 years ago, but it was not until 1977 that Frederick Sanger, at Cambridge, and Walter Gilbert, at Harvard, independently developed techniques for large-scale DNA sequencing and cloning. As scientists rushed to decode genomes from 50 to 100,000 bases in length, it became obvious that the flood of information would swamp them all unless someone volunteered to compile and manage it.



Goad, chief genetic librarian at GenBank.

Los Alamos had by then assembled the country's preeminent team of theoretical biologists. They also possessed the one essential tool for research in molecular biology: high-speed computers. "To make sense of all this information pouring in," recalls Goad, "it became clear that we would have to make good and effective use of computers." So in 1979 he borrowed some Los Alamos computer time and declared himself open for business as a genetic data bank.

Found in one of the newer Quonset huts outside the security fence at Los Alamos, GenBank itself is no more impressive at first sight than a handful of video terminals. Its screens are covered with spidery strings of *A*'s, *C*'s, *G*'s, and *T*'s—short for adenine, cytosine, guanine, and thymine, the nucleic-acid building blocks of genes. This four-letter genetic alphabet spells out the vast array of proteins that make up living organisms. Sequence these nucleic acids one way and—presto!—up pops the formula for a turnip-yellow mosaic virus. Reshuffle them in a different pattern and you could end up with the recipe for herpes virus.

Only the excruciating accuracy of a computer can keep genetic "mistakes" like the latter from happening. Computers are also required to annotate DNA sequences; that is, to read in these long strings of letters the specific "start" and "stop" signals of the code that regulate genetic expression.

"It gets even more complex when you try to understand evolutionary change at a molecular level," says Goad. How, for example, does one make sense of the enormous biological differences between man and chimpanzee when it is now known that we have 99 percent of our genes in common?

Goad's experimental data bank quickly became the central clearinghouse for

CONTINUED ON PAGE 114

MISTMAKER

BREAKTHROUGHS

By Michael Edelhart

A Washington, D.C., engineer and a Phoenix mechanic have proved that even in the Age of Corporate Patents, there's still room for the independent inventor working out of a garage and driven by dreams. Now their idea for a simple device that raises a car's gas mileage while cutting pollution appears ready to leave the garage and make its debut in American cars. In widespread use it could slash by almost 50 percent the amount of oil imported into the United States.

After dozens of false starts, engineer Sherwood Webster and mechanic Richard Heise created a valve that sits beneath an auto carburetor and, according to a Congressional Research Service report, does all of the following: cuts fuel consumption by 20 percent, increases engine torque by 13 to 40 percent, cuts carbon monoxide emissions by almost 50 percent and hydrocarbon emissions by up to 23 percent, and drops required octane ratings by 10 to 15 points.

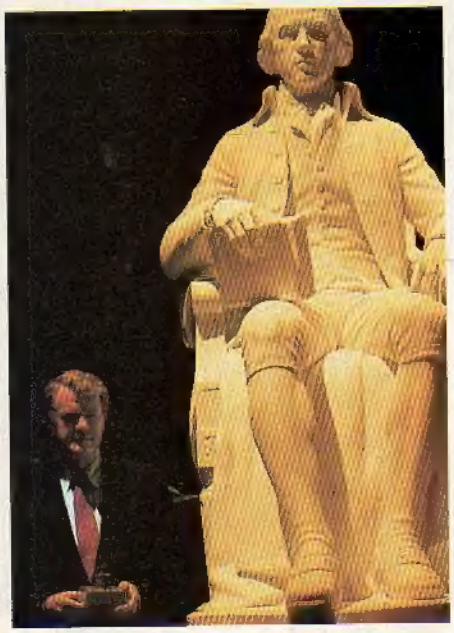
Octane is a measure of a fuel's ability to resist engine knock; higher-octane fuel requires additives and more crude oil per gallon than lower-octane fuel. The octane reduction of the Webster-Heise valve would translate into a 600,000-barrel-per-day oil savings if it were applied to every American car; the valve's gas-mileage improvement could save an additional 1.3 million barrels per day. The savings would add up to almost half the 4.2 million barrels of imported oil this country consumes daily.

Webster and Heise achieved these results by solving one of automotive design's oldest problems: how to fully and evenly vaporize gasoline. Carburetors mix air and gas to form a vapor that feeds the pistons. Inconsistencies in the density and chemical composition of gasoline create heavy drops that the carburetor can't break up. These drops burn poorly, leaving deposits that cause engine knock, increase wear on components, and lower efficiency.

The Webster-Heise valve sucks the gas-air mix from the carburetor, bounces it off a concave shield, and squeezes it through a sandwich of stainless-steel screens. The curved plate speeds up the mixture so that it hits the screens with enormous force. The arrangement of holes in the screens breaks even the heaviest drop into an invisible mist. The mix that results is almost totally uniform and perfectly blended.

The heart of the valve is the screen sandwich. Other valves with screens have failed, but this one succeeds because the sandwich creates a vibration pattern that pulverizes drops. Webster and Heise discovered their breakthrough in 1977 entirely by accident. Their 39 attempts to create a single-screen filter had all flopped. Then one day while washing off their stainless-steel screens with a hose in Heise's garage, they happened to hold two screens next to each other. To their astonishment the water spray vanished. It emerged from the second screen in a mist so fine, it was invisible. Two years of testing this effect resulted in the prototype valve.

"When we built the prototype," Webster recalls, "we didn't even understand why it worked. All we knew was that it did."



Heise and valve: Garage invention pays off.

"It's an inspiration," says Harvey Palmer, a chemical-engineering professor and distillation expert at the University of Rochester. "Two individuals with a solid guess. All the research money at GM and Ford just can't buy that."

Perhaps the most incredible feature of the valve is that it is expected to cost car manufacturers less than $100 to install. Chrysler, seeing the potential for a low-cost antipollution device to replace expensive catalytic converters, has licensed the valve and could begin using it in cars by the middle of the decade. Other American carmakers may follow, with government prodding.

NEW PRODUCTS

In the evolution of portable audio equipment, the Mister Disc (known as the Sound Burger, in Japan) falls somewhere between a Walkman and a minimalist record player. It's a clamplike device 11 inches long, 4 inches wide, and about 3 inches high. The record sits on a tiny spinning platter built into the lower arm of the clamp. The battery-powered unit comes with its own pair of high-fidelity stereo headphones, or it can be plugged into a standard speaker system. A carrying case is supplied, but the Mister Disc is hardly a stand-in for miniature cassette players: The system plays only when placed on a stable surface. ($170, from Audio-Technica U.S., Inc., 1221 Commerce Drive, Stow, OH 44224.)

A new, electric-powered massage table provides a Shiatsu back rub. The Acu-Massage table has eight rollers that act like fingers to massage the muscles in the back of the body from "head to heels." The rollers are adjusted to expand and contract to match the width of each vertebra, providing a gentle, wavelike motion that penetrates and relaxes taut muscles. Originally designed by the France Bed Company, of Tokyo, several years ago, the Acu-Massage table has just become available to Westerners. ($1,800, from H.W.E. Inc., 1638 North La Brea Avenue, Los Angeles, CA 90028.)

THE EL CHICHON INCIDENT

SPACE

By Richard C. Hoagland

Several months before the intended liftoff of the fourth flight of the shuttle *Columbia*, a Mexican volcano blew its top, spewing millions of tons of dust and gaseous material into a globe-circling cloud. The eruption was the first of a series of incidents revealing uneasiness in the relationship between the military and civilian components of America's space program.

The instruments aboard *Columbia* during the fourth flight, STS-4, were code-named Cirris (for Cyrogenic Infrared Radiance Instrumentation). Contrary to most media reports, the purpose and technology of Cirris had been made public almost a full year before *Columbia*'s "military" flight in July 1982. They were described in public testimony before congressional committees by an assistant secretary of the Air Force, Robert Hermann. Details from those hearings appeared, among other places, in *Aviation Week and Space Technology*.

According to reports at the time, Cirris was an earthward-looking supercooled infrared telescope. Part of its mission involved gazing high above the earth in search of new data on the so-called mesosphere (the region of space above the earth's horizon where Russian ballistic missiles would have to fly). Another part of the mission consisted of peering down into the lower atmosphere, gathering information on the region where "air-breathing" cruise-type missiles fly.

But while these plans were nearing completion, the Mexican volcano called El Chichon was filling this lower region with an impenetrable cloud, roiling up nearly 20 miles into the stratosphere, snaking all the way around the earth, blanketing the infrared region.

The cloud—the most unusual of its kind in 70 years—raised the clear possibility that Cirris would be unable to carry out all of its mission.

NASA was well aware of the cloud. Agency scientists James Pollack and Brian Toon, of the Ames Research Center, were responsible for tracking it, and they had begun to collect information that might help to answer some persistent questions. Such volcanic clouds have been suspected of causing major changes in the earth's climate. Some scientists have blamed them even for the ice ages. Whether or not their research could settle such issues, the scientists were a good source of data about El Chichon.

But both scientists told me that no one from the Department of Defense had been in touch with them about the potential effects of the cloud on Cirris. In fact, the scientists said they weren't even aware of Cirris or its impending flight.

For its part, the Air Force appeared to be as much in the dark about El Chichon as NASA was about Cirris. Donald Smith, program manager for Cirris at the Air Force Geophysical Laboratory, near Boston, confirmed that he had made no contact with NASA Ames about the potential impact of the eruption on his mission. Smith said he hadn't known of the volcano until well after the Cirris flight, when he "noticed the spectacular sunsets produced by the debris suspended in the upper atmosphere."

Was he aware that the National Weather Service had issued warnings about the cloud to users of its satellite infrared data? No. "I guess I don't know the details, to be honest," Smith said.

Globe-circling cloud threatened a mission.

Smith said the Air Force was primarily interested in the region above 100 kilometers, not in the lower layers occupied by the volcanic cloud. This seemed to contradict *Aviation Week* and its sources that there was high interest in "Soviet air-breathing threats." And it appeared unlikely that our Air Force wouldn't be keenly curious about infrared patterns in atmospheric layers where Soviet cruise missiles might someday fly.

In any case, it was obvious from these conversations that there had been no direct contact between the Air Force planners running the Cirris program and the NASA scientists who could have provided timely data on the potential impact of El Chichon upon the Cirris flight. More surprising, there was apparently no systematic liaison between Air Force and NASA scientists involved in basic research. Again and again Smith emphasized that Cirris was a *research* program, designed to gather basic data on a region of the atmosphere where we "basically don't have any data at all." Smith was apparently unaware of a NASA Solar Mesosphere Explorer satellite, which has been monitoring this region, and which has been NASA's prime source of data on the El Chichon debris.

All of this is slightly academic (at least, until the next flight of Cirris on the shuttle), because the Air Force device failed in orbit. The cover protecting the Cirris optics in the payload bay of *Columbia* would not open on command.

But even if Cirris had worked and had penetrated the cloud, some large questions would have loomed over STS-4 and the entire space program. How much vital scientific data are we losing because Air Force satellites aren't plugged in to any NASA systems? And how much military information is being compromised because of lack of NASA input from its satellites in areas where the Air Force Geophysical Laboratory insists there are no data?

SEX AND THE SPLIT BRAIN

MIND

By Carol Johmann

When she was a PhD student at Columbia University physical anthropologist Christine de Lacoste-Utamsing was dissecting human brains as part of her research. In the course of her work her attention was drawn to a fat bundle of nerve fibers called the corpus callosum that connects the right and left hemispheres of the brain. After examining specimens from nine men and five women, she noticed an odd thing. On average, the corpus callosum was larger and more bulbous in women's brains than in men's. Intrigued by this, she has since gone on to study more specimens, including the brains of both adults and fetuses. Her data have led her to one conclusion. The brains of men and women are physically different.

De Lacoste is still fascinated by her work and loves to talk about it, but she's concerned that people might jump to the wrong conclusions. She worries that her discovery might be used to support a controversial hypothesis that women's brains are less specialized than men's, a theory often cited by some researchers to explain why men tend to outperform women in such visual-spatial disciplines as geometry or engineering.

"Studying areas of the brain is very exciting," says De Lacoste, now at the University of Texas's Health Science Center, "but [my findings] can be twisted in a very sexist way. All I've shown is that there is a difference in the number of connections between hemispheres."

"What gets me is the leap some people make," adds City University of New York psychologist Florence Denmark, who has been following this research. "They assume that brain differences between the sexes always indicate differences in intelligence and ability. And somehow men always come out on top."

Such concern is hardly unwarranted. The notion that "biology is destiny" has been used repeatedly over the years to support a variety of racist, sexist, and other prejudicial attitudes. In his book *The Mismeasure of Man*, Harvard paleontologist Stephen Jay Gould points out how vulnerable a topic the brain is for misguided use of research. Bigots have long manipulated IQ-test results and comparative studies of brain size to support their views. What De Lacoste and others are trying to do is to put the new brain discoveries into the proper perspective before something similar happens with those findings.

Since the early Seventies there has been an increasing body of evidence that the brains of males and females differ. Studies of rat brains, for example, disclosed structural brain differences between the sexes in the hypothalamus—the section of the brain that regulates sex drive, body temperature, and blood pressure—and in the cerebral cortex, the control center for thinking, the senses, and movement. De Lacoste's research showed that there were sex-related differences in the human brain as well.

Brain researchers now assume that a larger corpus collosum means there is more communication between the right and left halves of the brain. This assumption and data from De Lacoste's research are significant when we realize how divided the brain is in its abilities, especially when we consider how that split may differ between the sexes.

The human brain is split in two ways. First, each hemisphere controls the movement of, and receives sensory input from, the opposite side of the body. Second, each half is specialized, or lateralized, as scientists like to say. The left brain handles information in an analytical, sequential manner. It is concerned with problem solving, and it excels in language skills. We use it to understand spoken instructions, for example. By contrast, the right brain appears to process information holistically—that is, more intuitively and perceptively. This is the brain half used to recognize visual patterns and three-dimensional objects. (See the interview with Roger Sperry, page 68.)

By connecting the two halves and getting them act as a whole, the corpus collosum keeps us from feeling like some kind of two-headed, or at least two-minded, beast. So if the female's larger corpus collosum allows for more of this

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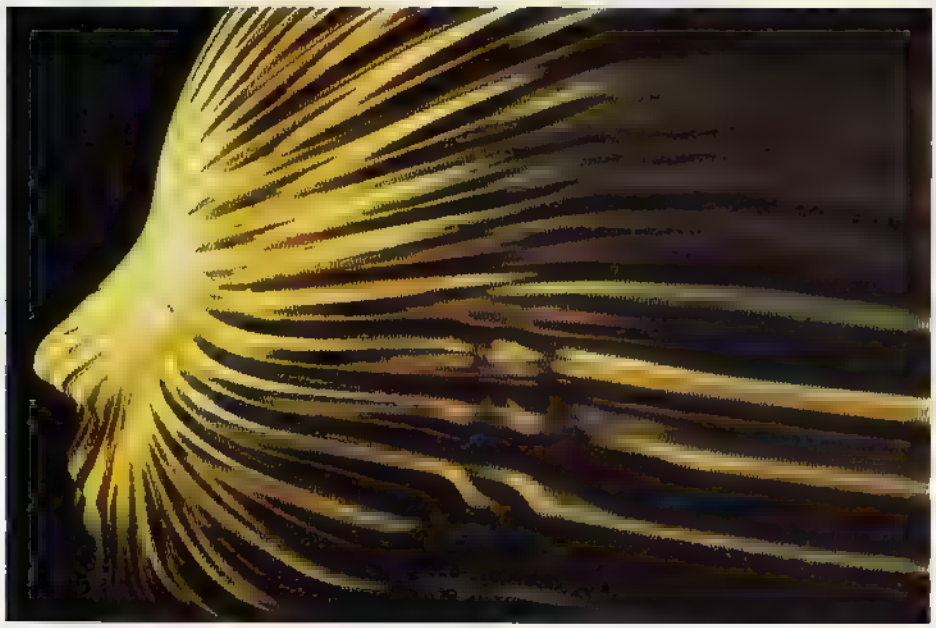


Woman has a structurally unique brain. How does it affect her perception of reality?

ARTIFICIAL INTELLIGENCE

By Michael Edelhart

How long does it take to count all the atoms in the universe?

For a human being, the task is impossible. A home computer might be able to manage the effort, given a few millennia. A powerful IBM mainframe could spend a few years at it. But Seymour Cray's computer can provide the total during a coffee break.

In fact, Cray's $8 million computer, the Cray-1, found the largest known prime number in just 20 minutes. The 13,395 digit-long integer is larger than the number of atoms in the universe.

Now Cray is about to introduce a machine that will make everyone else's computers look like children counting on stubby fingers. The new $12.6 million Cray X-MP due this fall, will be two to five times as fast as the Cray-1. And within two years we can expect yet another monster machine, the Cray-2, which will blast through more than half a billion calculations per second.

Cray, fifty-four, designs and builds supercomputers, machines that process information more than 100 times faster than typical large computers. Since the early Sixties when Cray and colleagues developed the Model 6600, the world's first supercomputer, he has dominated the field in a way few individuals can. He founded both the leading supercomputer builder in the world—Cray Research, Inc.—and its principal competitor, Control Data Corporation. While computer developers in California's Silicon Valley, Cambridge, Massachusetts, and Stanford, California, have become household names, Cray has quietly gone about the business of creating number crunchers in his small Chippewa Falls, Wisconsin, laboratory. In a computer world where everything becomes outmoded instantly, Cray's computer has been the world's fastest for seven years, the company claims. Since it was released in 1976, nothing on earth has caught up with the Cray-1 for certain applications.

But that long dominance at the top of the computer heap is now being challenged. Japan has announced a national effort to beat America to the next generation of supercomputers. Fujitsu has already announced its intention to manufacture a computer six to eight times more powerful than the Cray-1. And a U.S. government panel headed by Dr. Peter Lax of New York University determined that "under current conditions there is little likelihood that the United States will lead in the development and application of this new generation of machines." This has made the government so nervous that it has established three different study groups to examine the problem simultaneously.

The thought of losing the supercomputer lead scares the government, the world's biggest buyer of supercomputers, because of the many vital and special jobs supercomputers can do. They help the Pentagon play war games (WOPR, the villain of this summer's film *WarGames*, is a rogue supercomputer). They create elaborate mathematical models of atomic phenomena, formulate and test airplane components through a lifetime of wear in mere minutes, and follow the courses of thousands of celestial bodies through millions of years across the universe.

The mighty processors play a crucial role in industry too. Many companies lease time on supercomputers to solve problems their own machines simply can't handle. Scientific Software, for example, a petroleum consulting firm, buys help from a Cray-1 to simulate the pressure and volume inside petroleum reservoirs when fluids are injected into them (to break loose more oil from underground chambers). The simulation requires the computer to solve a series of differential equations that describe 10,000 three-dimensional coordinates, each representing a specific point in the subterranean oil field. This is 50 percent more coordinates than any lesser computer can handle, allowing the company to report more accurately on larger oil fields.

Even moviemakers are turning to supercomputers. This year Digital Productions, a Hollywood special-effects

New generations of computers are more than 100 times faster than earlier models

CONTINUED ON PAGE 118

THE ARTS

By Brian McKernan

Ultimately, computers can be a destructive force that prevents people from relating to one another. Computers are misused in *Superman III* by certain bad elements who are trying to take over the world. They are abetted by Richard Pryor's character who eventually realizes that a high-tech scheme he's been led into is evil. Whether to stay with it or not is the moral choice he has to make.

Christopher Reeve, famous for his portrayal of the latest incarnation of what has been called the most widely known figure in American fiction, is discussing his third and, he says, final appearance as the caped extraterrestrial. The film, directed by *Superman II* veteran Richard Lester, also features comedy superstar Richard Pryor, who adds plenty of laughs to this fantasy of human greed and artificial intelligence.

"The film takes place in 1983, with contemporary people who have the larger-than-life hero, Superman, in their midst. It is really a comic book, and within that we play it straight," Reeve explains. "The movie literally starts on a matchbook cover. The opening shot is of Richard Pryor – a guy out of work who picks up a matchbook that reads: EARN BIG MONEY BE A COMPUTER PROGRAMMER. Whereas the other Superman films started big (outer space, other planets) and worked down, *Superman III* starts small and develops into an epic-size movie."

But is there an antitechnological bias present in the film? "There certainly is from Richard Lester's point of view. One of the premises of this movie is that as we move into the future and toward high tech we must try not to move away from *people*. That's Lester's bias and my bias, and it definitely works into the story. Getting a machine to do all our work for us isn't necessarily a good idea."

Lester, an American who achieved success in England directing the zany 1964 Beatles classic *A Hard Day's Night*, and who has imbued all of his films (including *Help!*, *A Funny Thing Happened on the Way to the Forum*, *The Three Musketeers* and *The Four Musketeers*) with his own brand of humor, opens *Superman III* with a collection of slight gags of extraordinary urban calamities. "The style with Lester is not just to spoof any values or anything, but to show absurdities in the world," Reeve explains. "I had a discussion with him about the way computers round off decimals on paychecks to the nearest number. There's a great many fractions of cents that get stored away someplace, and the man who could tap into that would have a windfall. Lester liked Reeve's idea and used it for Richard Pryor's character, computer hacker *extraordinaire* Gus Gorman. Gorman's silicon larceny causes him to be blackmailed into assisting his employer, industrialist Ross Webster (Robert Vaughn), who plots to control the world's oil supply. As for Clark (Superman) Kent, he's away on assignment for the *Daily Planet*.

"Clark goes back to Smallville for his high-school reunion, and he makes a new friend. Reeve reveals: "He meets a girl he knew as a kid, named Lana Lang [Annette O'Toole]. She's divorced, has a nine-year-old son, and is trying to make a living. Clark and Lana renew their friendship. She likes him, and there's a kind of attraction there, but they're just friends, really. Remember, at the end of *Superman II* he causes Lois Lane to forget that they had a relationship. That was the end of romance for Superman. Lois was his one true love. It didn't work out, and there won't be another. The idea of hopping from bedroom to bedroom in contemporary fashion I think would be wrong for Superman.

"Also, you'll see a far more normal Clark Kent. If you remember in the first movie, when he was growing up, he was an average farm kid with no behavioral problems. He didn't stutter and push his glasses around, that was all a disguise he invented for living in the city. When he goes back to Kansas you see him drop all that and ask himself, *Why do I do all this shtick?* Clark helps Lana without putting any pressure on. When men and women aren't trying to impress each other, there's a good chance that something very close can develop."

CONTINUED ON PAGE 115

Superman's troubles begin when Richard Pryor slips him some kryptonite in Superman III

CONTINUUM

R.D. LAING'S NEW HOME

A few years ago a troubled young Londoner moved to a new house. In the process of his search, he also found a new, more humane brand of psychotherapy and a second chance at life.

Before arriving at his new home, the twenty-three-year-old had been hopelessly psychotic. In and out of mental hospitals for years, he had suffered close to 100 convulsing electroshock treatments at the hands of well-meaning psychiatrists. But these brutal sessions did no good.

In the new residence, he and other psychotic patients lived freely, without psychiatric supervision. He chose to spend most of his time alone in bed, absorbed in what he described as "deep thinking." Though he received no treatment of any kind, he emerged from this insular world after two years to reestablish contact with reality.

This sort of success comes as no surprise to charismatic Scottish psychiatrist R. D. Laing, who founded the residence and its umbrella organization, the Philadelphia Association, in 1965. (*Philadelphia*, Laing explains, is the Greek word for "brotherly love.") Laing, author of *Knots* and *The Politics of Experience*, is best known for popularizing the view of psychosis as a sane response to an insane world. Some 20 years ago he illustrated that theory with a simple analogy. Imagine a single bird that veers from its flock in midflight. The flock, Laing said, might be heading toward disaster while the one would land safely on the ground.

Like the solo bird that *seems* to be out of formation, holds Laing, the twenty-three-year-old's psychotic interlude was actually a journey toward salvation. Moreover, his journey could never have ended if it were interrupted by electroshock therapy and drugs that halt emotional growth.

To speed the journey, each of the association's four houses forms a "therapeutic community," a place where eight to twelve mentally disturbed people "cultivate the art of living together." Each association resident helps with cooking, cleaning, and shopping: all the routines of daily life. Some people practice yoga or meditation; others spend time on music and art; and still others, like the young man, do nothing at all. Such important decisions as admitting a resident or occasionally expelling one, are voted on democratically. Everyone has his own room and key, comes and goes as he pleases, remains alone, or keeps whatever company appeals to him.

When confused people in the throes of psychotic breakdown show up at the door, house residents and a therapist team up to give around-the-clock care. But the on-call psychiatrist, who does not live in the house, intercedes only sparingly in the residents' day-to-day lives. And although the association does not discourage prescription drugs, adds Laing, patients are free to live without them.

According to psychologist David Goldblatt, formerly a Philadelphia Association house therapist, patients who live through psychosis without the dulling impact of drugs may lose their symptoms in just a couple of weeks. Residents weaned off conventional treatments *do* sometimes freak out. "People hit me," reports Goldblatt. "I've been bitten, and one guy came at me with a kitchen knife." Nonetheless, of more than 600 people who have stayed at the houses, few reportedly ever see a psychiatrist or go to a mental hospital once they leave the program.

Laing has recently resigned from the Philadelphia Association's governing board with hopes of setting up a training center, perhaps in Switzerland, where psychotherapists will learn to run households like those in London. If those plans come to fruition, the center might also offer classes in the martial arts so that students could defend themselves against violent patients.

Despite the opposition of traditional psychiatry, therapeutic households are beginning to spread in the United States. Goldblatt is cofounder of Burch House, a retreat in New Hampshire's White Mountains, where therapists and those suffering mental crises share a 19-room home. "For the most part," Goldblatt says, "people structure their time here themselves." Staff and clients do minor repair work on the house, cook and shop, care for a vegetable garden, and split wood to heat the house in the winter. Drugs are generally shunned, but formal counseling with a therapist is encouraged.

More than 40 clients have passed through Burch House, many with a long history of stays in mental hospitals; 60 percent have successfully returned to society. The bottom line, Goldblatt believes, could be a revolution in psychotherapy. In the presence of caring and supportive people, he says, the insane often "find their own way through the healing process."—*ERIC MISHARA*

CONTINUUM

BOVINE IMMORTALITY

At age 14 Sabine the cow had enjoyed a distinguished breeding history. Though she herself was not a prize animal, nearly every one of her calves had grown up to become an outstanding bull or heifer. And her embryos consistently fetched as much as $10,000 apiece on the booming embryo-transfer market. But her last pregnancy proved to be her undoing. There were difficulties at birth, and three days later, at 4 A.M., Sabine died.

But her owners, Genetic Engineering, Inc., of Denver, acted quickly. In an emergency operation, they removed the dead cow's ovaries and extracted 80 unfertilized eggs. The smaller eggs were immediately frozen in liquid nitrogen. The larger ones were allowed to mature in a special culture, then joined their younger cousins in the deep-freeze.

Genetic Engineering had been working toward this moment for almost two years. "The question we had asked ourselves," explains company research consultant Jonathan Van Blerkom, "was, Can we take these eggs during the maturation period, freeze them without killing them, then thaw them out and have them resume maturation? We were finally able to accomplish this."

What has yet to be accomplished is successful fertilization of the thawed eggs. Attempts have thus far failed, Van Blerkom suspects, either because researchers have put too many sperm cells in the fertilization dish or because they have put them in an inappropriate solution.

Van Blerkom is confident, however. "It's very possible," he adds, "that we'll eventually be able to do the same thing for a dying woman that we did for Sabine."—Bill Lawren

"Better a diamond with a flaw than a pebble without."
—Chinese proverb

The late Sabine, supercow. Her nonpareil breeding history has inspired her owners to immortalize her genes in a petri dish.

Young addicts had a bizarre form of Parkinson's disease.

BAD TRIP

It began when a forty-two-year-old man showed up at the Santa Clara Valley Medical Center, in San Jose, California, with some baffling symptoms: a mask-like expression, drooling, rigid posture, and a shuffling gait—all classic signs of Parkinson's disease. But Parkinson's disease is an affliction of old age, rarely seen in people under sixty. Unable to speak, the man scrawled a haunting message on a notepad: WHAT'S HAPPENING? NOTHING WORKS.

It took astute guesses by Stanford University neurologist J. William Langston and other medical sleuths to find the answer. The "Parkinson" patient, they learned, was an addict who had become ill after injecting what he supposed was synthetic heroin. Then, over the next few months, half a dozen other heroin users, all, between the ages of twenty and thirty, appeared with the same tragic symptoms. Many were bedridden and unable to speak; all had bought "synthetic heroin" that police traced to one illicit lab.

The drug samples revealed a compound so obscure that its chemical "fingerprint" was unlisted. But, fortunately, Langston stumbled on a 1976 medical journal that described a similar case: a young graduate student who had contracted "Parkinson's disease" from homemade heroin and later committed suicide. The autopsy revealed a chemical called 1-methyl-4-phenyl-1,2,5-tetrahydropyridine, or MPTP.

The culprit in the San Jose cases turned out to be the same chemical, the result of an underground chemist's blunder. Trying to make synthetic heroin in the form of a chemical called MPPP (1-methyl-4-phenyl-4-propionoxy-piperidine), he had unleashed the toxic by-product MPTP instead. MPTP apparently kills nerve cells in the nigrostriatal pathway, the part of the brain affected by Parkinson's disease, triggering a permanent parkinsonian condition.

"Ironically," notes Langston, "we've never had an animal model of Parkinson's before. Now we may have one." By using MPTP to induce the disease in rats, researchers can try out new drugs or even find a cure.
—Judith Hooper

In our galaxy's hinterlands, astronomers have seen soap

SPACE SOAP

Radio astronomers scrutinizing the cosmos can find the most mundane of things—sodium hydroxide, for instance, a chief ingredient of earthly household soap. The chemical's appearance in the constellation Sagittarius, however, has some far-from-mundane implications.

This is the first time a compound containing the simple element sodium, a mineral essential to life, has been spotted in space. And its discovery by astrophysicist Jan M. Hollis of NASA's Goddard Space Flight Center, in Greenbelt, Maryland, and Paul J. Rhodes, chief telescope operator at the National Radio Astronomy Observatory in Tucson, Arizona—bolsters the theory that life's building blocks were formed in space before they evolved down here on Earth.

Scientists don't literally "see" chemicals in space, of course; instead, they detect a chemical's presence—using a radio telescope—by its characteristic electromagnetic wavelength, or signature.

When Hollis first noticed sodium hydroxide in the vicinity of Sagittarius, he and Rhodes worked around the clock observing the constellation through the Tucson Observatory's 11-meter telescope on Kitt Peak. The finding? The "soap" seemed to be emanating from clouds surrounding the center of the Milky Way.

"We now know," he says, "that molecules evolve in space. Simple species on Earth tend to evolve into more complex species. What we don't know at this point is how far this evolution is carried in space."

—Rick Boling

"An expert is a man who doesn't know all the answers but is sure that if he's given enough money, he can find them.

Rex Fletcher

"I recently learned something quite interesting about video games. Many young people have developed incredible hand, eye, and brain coordination in playing these games. The Air Force believes these kids will be outstanding pilots. Homework, sports, and friends still come first."

—President Ronald Reagan

PREHISTORIC HORSEMEN

Paleontologist Henri Martin was scouring the prehistoric sites of southern France in 1911 when he found several pairs of worn-out horse teeth. The teeth, which were estimated at 30,000 years old, showed signs of cribbing—the habit of biting a railing, rope or even nearby rock.

An obvious sign of boredom, cribbing is exhibited only by captive animals, never by those in the wild. Martin naturally concluded that humans had domesticated horses tens of thousands of years ago, contradicting the long-standing theory that control of animals hadn't begun until 6000 B.C. Martin promptly published his evidence but was ignored.

Martin's explosive theory had been buried for 70 years when archaeologist Paul Bahn, a research fellow at the University of London, came across the paper. Intrigued, Bahn soon tracked down several of the teeth found by Martin and dug up new ones on his own. His conclusion: Martin may have been conservative. Men were controlling horses *at least* 12,000 years ago, Bahn says, and possibly were doing so as long as 100,000 years ago.

Bahn suspects that the animals were corralled, ridden and kept for meat. "Considering what the American Indians were doing with horses after they'd been exposed to them for only a couple of hundred years," he says, "I think it highly likely that among a people who had lived in close proximity to horses for thousands of years, someone is going to have the idea that you can do more than chuck a spear at them."

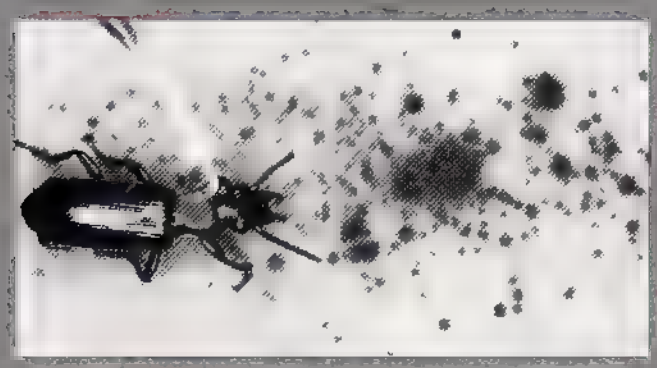
—Timothy Perrin

"The observer, when he seems to himself to be observing a stone, is really, if physics is to be believed, observing the effects of the stone upon himself."

-Bertrand Russell

Cave paintings at Lascaux: For prehistoric humans, horses were not merely objets d'art, they were also domesticated animals.

CONTINUUM



Using photomicrography, scientists have watched the bombardier beetle (shown above at left) carrying out high-tech warfare

BOMBARDIER BUG

For years entomologists have pointed to the bombardier beetle as an insect that used rocket technology long before man discovered it. The minute bombardier launches scorching blasts of benzoquinone, a toxic spray, from its hindquarter glands into the face of its archenemy, the ant. It does this by releasing hydrogen peroxide and hydroquinine from one chamber into another, triggering an explosive chemical reaction.

Now biologist Thomas Eisner and engineer David Aneshansley, both of Cornell University, say bombardier beetles, of the subfamily Paussinae, make use of yet another sophisticated physical principle, the Coanda effect, best illustrated by liquids that dribble down the curved surface of a container instead of flowing out smoothly.

Paussinae beetles, the researchers explain, have grand openings at the rear and can't twist around to splatter approaching predators. To compensate, they've developed curving, rimlike projections—or flanges—aligned with the glands. Using photomicrography, Eisner and Aneshansley have seen the bugs employing the Coanda effect to thrust their toxins forward.

"The flanges serve as launching guides for the spray," Eisner says. "The jet of fluid is *bent* into its trajectory." The upshot: The ant gets sprayed in the face.

—Susan S. Lang

GENES THAT GLOW

Genetic engineers have manufactured another first—intestinal bacteria that glow in the dark.

At the Agouron Institute in La Jolla, California, common *E. coli* bacteria from the human gut are emitting an eerie blue-green glow. Its source: a foreign gene clipped from a simple sea creature called *Vibrio harveyi* and spliced into *E. coli* DNA. The cloned gene codes for luciferase, the enzyme that makes Vibrio bacteria "bioluminescent" by moonlight, and it endows the gut microorganisms with the same gift.

The Agouron researchers, according to chief biologist Michael Silverman, hope to use their technique to isolate the genetic material that makes vibrio sticky. Vibrio, Silverman explains, is a common marine bacteria that adheres to ship hulls, forming a slime that attracts barnacles and other messy marine life forms. If researchers could understand the genetics of bacterial stickiness, they might be able to interfere with it.

But the stickiness factor involves probably dozens of genes. So the genetic engineers decided to test their tools on the simpler problem of bioluminescence. First they had to *find* the gene that instructed the bacteria to make luciferase. To do that, they mixed the bacteria with transposons, snippets of DNA that act like circuit breakers; whenever a transposon is absorbed by a gene, it renders that gene inactive. Thus, whenever a luciferase gene absorbed a transposon the bacterium ceased to glow.

By pinpointing transposons in nonglowing bacteria, the researchers were able to locate the luciferase gene. From there it was relatively easy to transfer the gene from vibrio to *E. coli*. Moreover, the same technique can be used to locate and transfer many other genes, including those for stickiness.

Bioluminescence itself, Silverman adds, is a biological riddle. "A cell expends a lot of energy glowing in the dark, but we don't know what value this has for bacteria. Bacteria don't glow in the dark when they're alone, only when lots of them get together."

—Paul Raeburn

"I am unique. Never again will this aggregate of atoms stand on Earth."

—Max Stirner

Barnacle formation is genetically complicated, so bioengineers first isolated the DNA that makes marine bacteria luminescent

MELTING HARDENED ARTERIES

Atherosclerosis is the scourge of the elderly: As the years pass, fat often builds up within artery walls, restricting the coronary vessels and blood supply to the heart. The condition, commonly called hardening of the arteries, is irreversible. And its deadly effect is ameliorated only by bypass surgery, with all the risks and bills.

If a Chicago physician's experimental technique pans out, however, future patients may be able to regain their health without going under the knife. Developed by heart surgeon Robert Gordon, of the University of Illinois Medical Center, the new method uses electromagnetism to "melt" the fatty deposits, or plaques, away.

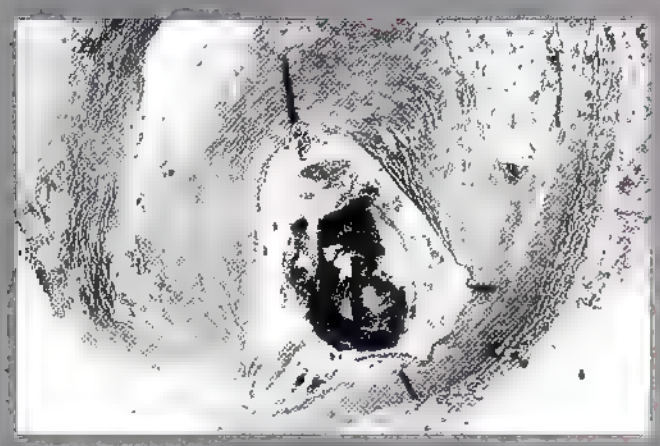
To melt the fat, Gordon first injects a solution of such tiny magnetic particles as iron hydroxide into the patient's bloodstream. The particles collect in the plaque-damaged areas, which are more permeable than normal blood-vessel walls. Then the patient is placed inside a large induction coil and subjected to a high-frequency alternating electromagnetic field. The field interacts with the particles, generating heat, the heat melts the fat, leaving normal tissue unscathed.

Gordon has thus far used his new technique only on rabbits and rats, and it may take several more years of testing before it's available to humans. But some of his colleagues are already forecasting a new era of heart-disease treatment, and Gordon is cautiously optimistic. "It's possible," he notes, "that we'll even be able to *prevent* hardening of the arteries by melting newly forming lesions."

—David Dreier

"Happiness hates the timid. So does science!"

—Eugene O'Neill



Clogged coronary artery. Now the only remedy is a heart-bypass operation, but a new technique "melts" plaques nonsurgically.

The contents of your id are supposed to be confidential, but most therapists have no qualms about using collection agencies

THERAPY AND BILL COLLECTION

Robert Jones has been down on his luck—divorced, troubled, and unemployed. Now in the process of getting back on his feet, Jones applies for a sensitive job with a government agency. But a routine check of his credit history shows that a psychotherapist once turned Jones's unpaid bill over to a collection agency. Alerted to the fact that Jones was once in therapy, his prospective employer rejects him as "unstable."

While fictional, this scenario is the plausible outcome of an ethical—and legal—issue that affects both psychotherapists and their patients. According to guidelines set down by the American Psychological Association (APA), information gathered by a psychologist working with a patient is considered strictly confidential and cannot be turned over to a third party without the patient's consent.

But a study by psychologist William Faustman, now with the Veterans Administration Hospital in Palo Alto, California, shows that when it comes time to collect bills, most psychologists have no qualms about reporting a patient to a collection agency. Of the 148 psychologists in private practice who responded to Faustman's questionnaire, 60.8 percent reported that they had used collection agencies. Of those, fewer than half had informed their patients of the possibility beforehand.

Many psychologists argue that they are simply providing a service, and if the client does not pay for the service, the psychologist has the same right as any other professional to use legal means to collect. But Faustman feels differently. "If you buy into the APA's ethical guidelines," he says, "then giving information to a bill-collection agency or a lawyer constitutes release without the patient's consent."

—Bill Lawren

"A pig bought on credit is forever grunting."

—Spanish proverb

CONTINUUM

A young subject's brain is tested for specialization

ASYMMETRICAL BABIES

As scalp electrodes recorded her brain waves a ten-month-old baby squealed with delight at the videotaped hamming of a grown-up actress.

The part of the baby's brain that got a kick out of the actress's antics was the left frontal lobe—the same area that would register such stimulation in an adult brain. The electroencephalograph (EEG) readings, says Richard Davidson a neuropsychologist at the State University of New York at Purchase, are the first evidence that the brain's hemispheres may already be specialized in infancy. This contradicts old notions that only as the brain matures do its two halves start processing emotions selectively.

Davidson and co-worker Nathan Fox, of the University of Maryland, College Park, monitored the frontal and parietal lobes of 24 ten-month-old babies who were entertained by videotapes of an actress laughing and crying. Unlike the emotionally responsive left brain, the right frontal and parietal lobes showed no EEG changes.

Brain asymmetry, Davidson asserts, may begin at birth. He also speculates that the left hemisphere may specialize in positive or "approach" behaviors; the right, in negative, or avoidance, reactions. Already scrutinizing newborns for asymmetrical brain activity, the psychologist hopes to move on to babies of psychiatric patients to see whether the offspring have their parents' brain patterns. —Madeleine Nash

"The way to happiness does not include murdering your friends, your family or yourself being murdered."
—L. Ron Hubbard

"Midnight shakes the memory as a madman shakes a dead geranium."
—T. S. Eliot

BLACK MAN'S HEAD

A mysterious Amazon tree with the colorful name of Black Man's Head appears to contain a snake-venom antidote so potent it can bring animals back virtually from the dead. Chemists in the United States and Japan have synthesized the plant's active ingredient, but they don't know the identity of the natural source.

At least a dozen South American plants share the name of Black Man's Head, or *Cabeza de Negro*," explains Koji Nakanishi, of Columbia University, "and the woman who supplied the extract would not tell us which one it came from."

After Nakanishi's group isolated and described the structure of the antidote molecule, other scientists tested it on mice and dogs that had been given two to three times the lethal dose of venom from a snake known as fer-de-lance (*Bothrops atrox*). They found that the antidote successfully restored heartbeat, blood pressure, and respiration to normal within approximately two hours. What's more, Nakanishi believes that the antidote may be effective against venom from many other snake species as well.

Legend has it that certain animals seek out Black Man's Head after they have been bitten by a snake. And Nakanishi suggests that rubbing against the plant might reward some animals with immunity to snakebite. But even without the plant, humans may benefit from the antidote's powers. Since scientists can synthesize the valuable compound, they may soon start manufacturing batches in the lab.
—Dava Sobel

"Usually when people are sad, they don't do anything. They just cry over their condition. But when they get angry, they bring about a change."
—Malcolm X

RADIOACTIVE GEMS

Wholesale jewelers in Los Angeles recently bought a collection of Brazilian gems. But when the stones were tested with a Geiger counter, they turned out to be "hot."

Snakebite need not be fatal—as long as you're near the Amazon plant called Black Man's Head, nature's own antidote to venom

The jewels, in fact, were dangerously radioactive and this was the third such shipment in several years.

How did it happen? 'These stones were placed in a nuclear reactor,' suggests George Rossman, a California Institute of Technology mineralogist. It was a case of gem tampering with a scary twist.

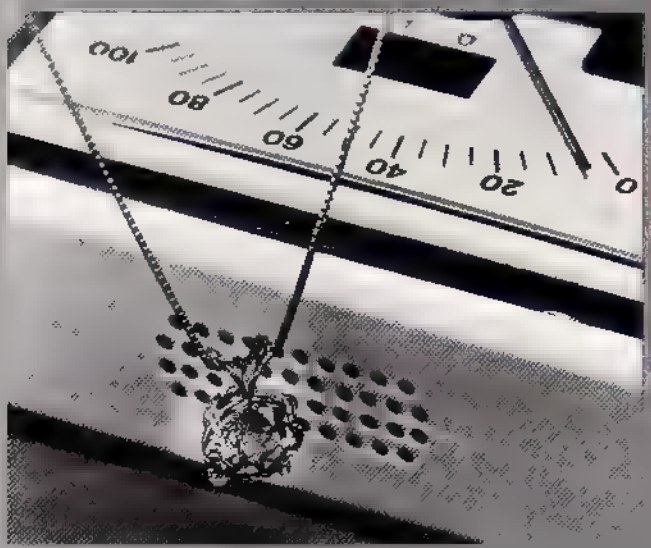
Low-level radiation in the earth's crust enhances the color of precious stones over vast geologic time periods, Rossman explains. Impatient with nature's sluggish course, some merchants resort to coloring gems with benign gamma rays, widely used to sterilize medical instruments and to package food. But this time, Rossman speculates, someone in Brazil irradiated topaz and the gem spodumene with neutrons from the core of a nuclear reactor.

If you wore one of the gems 24 hours a day for a year, he warns, you'd be exposed to radiation levels approaching the legal limit for nuclear-industry workers. And it might be a lot worse. "These stones could be worn as a necklace over the thyroid or lungs," he observes. "It is certainly imprudent to expose internal organs to this level of penetrating radiation."

The Brazilian government (a major gem exporter to the United States) has been notified that some of its stones are "hot," reports a Nuclear Regulatory Commission official in Washington, D.C. And many gem merchants now use Geiger counters to inspect their wares.—Eric Mishara

"Nature composes some of her loveliest poems for the microscope and the telescope."

—Theodore Roszak



The Geiger counter has been the jeweler's best friend ever since unsavory gem traders began dallying with nuclear reactors.

RELIEF FOR CANCER PAIN

The pain suffered by terminal cancer patients is often too excruciating to alleviate with drugs, hypnosis, or other techniques.

Now physicians at Houston's M. D. Anderson Hospital and Tumor Institute have come up with a solution: injecting an opiate directly into the brain, where pain originates.

First, reports Dr. C. Stratton Hill, director of Anderson's pain clinic, a neurosurgeon drills a hole in the patient's skull above the forehead, creating a reservoir for the pain medication. Once a day the medication is placed directly into the area, which may be covered by a flap of skin. The patient then wears a wig.

Hill says that since the technique requires lower doses of morphine, patients suffer few side effects and may even remain active up to the time of death. So far, it has been successfully used on ten adults and one child.—Joan Goffman

MAN-MADE MUSCLES

Although they're more sophisticated than Captain Ahab's peg leg, today's artificial limbs still lag behind the real thing. But a sophisticated prosthesis may soon arrive. The secret, says physicist Toyiochi Tanaka, of the Massachusetts Institute of Technology, is a bionic jelly that expands and contracts much as human muscles do.

Once amputees wore peg legs, gel muscles will be softer.

The hallmark of muscle cells is their ability to contract rapidly when excited by a chemical messenger, then to resume their former shape. When subjected to a low-voltage electrical field, a gel does the same thing. Since gels can be molded into any shape, Tanaka explains, artificial limbs can be made of bundles of tiny gel cylinders that resemble muscle fibers. The gel "fibers" could be encased in a skinlike membrane and attached to steel or plastic bones.

Future amputees might wear tiny microcomputer devices to send electrical signals to their sculpted limbs, Tanaka adds. By regulating the volume changes of each gel cylinder individually, such computers could orchestrate complex movements.

The result, Tanaka concludes, would be an almost lifelike limb.—Leah Walach

"Some men go through a forest and see no firewood."

—English proverb

CONTINUUM

HISS BUNDLE

Stargazing doesn't ordinarily save lives, but celestial rhythms recently set an Israeli astronomer to thinking about the human heart. The fruit of his meditation is a down-to-earth medical invention.

Tel Aviv University professor Dror Sadeh had been using a computerized detector to differentiate between the regular but weak signals of pulsars and the background noise of the universe. He was sifting through the pulsar signals one day when it occurred to him that an analogous tool might pick up faint heart signals normally drowned out by the body's electrical noise.

He took his idea to Dr. Schlomo Laniado, director of cardiology at nearby Ichilov Hospital. Laniado heeded Sadeh's suggestion. Before long he found that a computer, working in tandem with an electrocardiogram, could record the activity of the hiss bundle, a column of muscle fibers running through the heart. When the hiss bundle malfunctions, heart disease may follow, but it's impossible to examine the electrically noisy fibers with a conventional electrocardiogram. By "absorbing" the body's noise, however, the computerized version was able to detect erratically functioning hiss bundles.

According to the researchers, the new cardiac detector may be used to measure other body functions as well. They are currently testing its effectiveness in monitoring breathing and blood pressure. —Paul Raeburn

"The present time has one advantage over every other. It is our own."

—Charles Colton

HUMANOID CHIMPS

Back in the early Thirties an exceptionally clever and sociable pint-size chimpanzee called Prince Chim inspired a book by the eminent Yale zoologist Robert M. Yerkes. Its title, presciently enough, was *Almost Human*.

What Yerkes didn't realize was that Prince Chim was no ordinary chimp. He belonged to a new species, the pygmy chimpanzee, which Harvard zoologist Harold J. Coolidge was to identify a few years later. And today the small primate—four feet tall, like a regular chimp but slighter in build—has become an anthropological curio. It may be humankind's closest living relative.

"Studying pygmy chimps in the wild will help unravel what human ancestors were like," says Randall Sussman, a primatologist from the State University of New York at Stony Brook. Sussman began doing just that two years ago in Zaire's Lamako Forest.

What makes pygmy chimps so humanoid? Well, unlike other African apes, they mate front to front, with elaborate courtship gestures. Sussman reports. They engage in much homosexual dallying, and the females are sexually receptive throughout the menstrual cycle. They are omnivorous and highly intelligent.

Researchers estimate that our common ancestor which lived about 4 million or 5 million years ago, might have looked like a small chimp. And they point to similarities between the pygmy chimp and "Lucy," the famous 3.6-million-year-old hominid fossil said to be our true ancestor.

"The pygmy chimp is not man's ancestor," Sussman cautions, "but it's the closest living representative."

—Tom Kovach

"Imagination is more important than knowledge."

—Albert Einstein

Beyond echocardiography: A computerized technique that locates pulsars can also be used to detect the heart's fainter signals

Pygmy chimps: Our closest animal relatives are four feet tall, swing from trees, and indulge in elaborate courtship rituals

ANIMAL FEMINISM

In the glaring sun of the Namib Desert of South-West Africa, a male spotted hyena feeds contentedly on a dead zebra. Suddenly another hyena, a large female, rushes in, teeth bared and tail up. The male pulls its tail between its legs and cowers, but not before the female gives it a nip in the neck. Retreating a short distance, the male watches the female leisurely take a bite out of the carcass. He knows that when she has eaten enough, he will be able to return to his meal—unless another hungry female comes by.

Ronald Tilson, an ethologist with the Oklahoma City Zoo, has seen this scenario played out time and time again in the wild. When a carcass is being eaten, he reports, females drive off males an average of ten times a night. Females get first choice of everything. Even the young pups of females eat before the males do. And what if there is a fight? "Females *always* win," says Tilson. "I have never seen a male supplant a female at a carcass." By almost anyone's criteria females come out on top in spotted hyena society. Tilson is so impressed by this fact that he even suggests Equal Rights Amendment proponents adopt the hyena as their mascot.

PAINTING BY ROBERT GIUSTI

Males, beware. Power is part of the feminine mystique, according to a new breed of animal behaviorists

Like other dominant female animals, the hyenas are heavier than the males, probably because they get first choice at the kills, suggests Tilson. Other differences are more than skin deep. For example, the female hyena's genitalia look almost exactly like those of the male. It has recently been discovered that female hyenas have high levels of the male hormone testosterone, and Tilson thinks this is the explanation for the similarities in the sexes' genitalia.

Tilson's work, along with similar studies, has added a new dimension to Freud's remark that "biology is destiny." Generations of social commentators have used that observation to support the claim that women's subservient place in society is an immutable fact of life. While Freud's observation still holds true, a new batch of studies from the animal behaviorists shows that biology no longer predestines a natural order of male supremacy—at least not in the animal kingdom. Today there are enough data from long-term studies of fish, birds, and mammals to indicate that females dominate males, or at least share dominance with them, more frequently than Freud or Darwin ever suspected. And among mammals, dominant females are most common in our own order: Primates.

Scientists used to think that, with

a few exceptions male dominance was the rule in the animal kingdom It's not hard to see how this view arose The first animal societies that behaviorists studied were those of such domestic creatures as the chicken, few males reign more supreme than a rooster in the barnyard In the wild the first primate subjects were baboons and rhesus monkeys They were chosen partly because they were easy to observe As it happens, males are dominant in both species, according to Linda Fedigan anthropologist at the University of Alberta and author of *Primate Paradigms* Other primates that had different life styles were largely unstudied by researchers in the early years of behavioral research

When scientists began to study animals in the wild they expected to find male dominance, not surprisingly, they did. Their prejudices were feeding their observations," says Harvard University anthropologist Sarah Blaffer Hrdy, whose book *The Woman That Never Evolved* explores the variety of primate lifestyles

Before long the idea that primates, and ultimately all creatures lived in male-dominated societies was firmly fixed in the minds of most scientists and in the texts they wrote There were of course exceptions Raptors hawks owls and other birds of prey had long been known to have dominant females But scientists tended to view these species as oddballs

Then in the early Sixties came an explosion of discoveries, as a new generation of scientists, many of them women studied a wider variety of animals over long periods of time These researchers found that among some animals, female dominance is the rule, not the exception. In fish societies for example females tend to dominate in any encounter, mostly because of their greater size and weight The classic example is the clown fish, a colorful species found off the coast of Japan

Clown fish travel in groups comprised entirely of males, with the exception of a single female, which reigns over them. It's the female not the males, that stakes out a territory attractive to the opposite sex an area dotted with sea anemones When a female dies a male may rise to power and step into the former leader's role, but only after he gains weight and literally changes sex becoming a female

"The most dominant male in the group turns female" reports ethologist Jeffrey Bayliss, of the University of Wisconsin. "In these fish, dominance and being female mean the same thing"

The same was found to be true for another animal species, the spotted sandpiper Not only are female sandpipers about 20 percent larger than the males, but they're polyandrous (having several husbands) as well, according to Lewis W Oring, of the University of North Dakota. For more than a decade Oring has made annual treks to study these birds at their mating grounds on a small island in a Minnesota lake The picture he paints of their sex life looks something like a male fantasy gone haywire

Females arrive early in the mating season to stake out their territories When the males appear, the females fight over them viciously, sometimes inflicting crippling wounds on one another While all this fighting is going on the males busy themselves building nests As soon as a female sandpiper has finished mating with one male she begins looking around for another fair prospect should hop into sight she will then take off with him, leaving mate number one to mind the eggs

Oring has seen a female mate with up to four partners laying a clutch of eggs for each After all these matings the female blithely ignores her mates and her numerous offspring unless the weather is unusually bad in which case she will lend her feathers to warming the nests

The sandpiper's practice of taking multiple husbands does not exist among mammals because mammalian mothers supply their young with one thing the fathers cannot: milk. Nursing ties these mothers more closely to their offspring As a result the world of mammals is primarily a polygamous one in which males take several mates Still, there are some monogamous mammal species and it is within this monogamous minority that we find dominant females

> *"When a female clown fish dies, it may be replaced by a male, but only after the male gains more weight and literally changes its sex, becoming a female."*

An expert on monogamous animals, Devra Kleiman, of the National Zoo, in Washington, D C says that among most of these mated pairs, females are either in charge or codominant, sharing the power with males A colleague of Kleiman's at the zoo Fred W Koontz has been studying a unique monogamous mammal, the elephant shrew A long-nosed long-legged little beast that hails from Africa, the elephant shrew looks something like a gerbil standing on stilts Unlike most monogamous animals which are paragons of togetherness, elephant shrews ignore each other except for the brief period of estrus when the female is in her fertile period If they encounter each other at any other time the female chases the male away And on the few occasions when the two interact there's really not much doubt about who's boss

"Elephant shrews have favorite resting places," explains Koontz "I've seen males sitting in these, and a female will come along and ram her head into him. She pushes him out and then spreads out there herself " Although elephant shrew females would hardly win a congeniality contest, they seldom fight with their mates a trait of most monogamous animals Among polygamous animals like the hyena females are much fiercer toward the males

Ounce for ounce, one of the most aggressive females in the animal world is the tiny Southern flying squirrel. (Females weigh only about three ounces, males tip the scales at even less) In her observations of this nocturnal creature biologist Jacquelyn Wells of Upsala College, has seen incidents of female dominance as striking as the female hyenas at feeding time At one feeding station she set up Wells recalls, "a male would start feeding, then a female would come along and pounce on him And he'd run away squeaking " After just one such encounter the male squirrel, like the male hyena would hang back respectfully waiting until the female had first eaten her fill

The greatest incidence of female dominance or codominance is found among the primates, our closest mammalian relatives One of the first observations of a primate society in which females are dominant was made by Alison Bishop Jolly of Rockefeller University During the early Sixties she studied ring-tailed lemurs on the island of Madagascar off the coast of Africa Jolly found that these monkeys live in separate male and female bands each having its own hierarchy Although females and males are about the same size whenever the two sexes come in contact the females invariably rule

Jolly reported seeing females bounce up to a dominant male and snatch a tamarind pod from him, cuffing his ear in the process On any number of occasions slaps from females were the males' only the males never hit back

Female dominance seems to be the rule among all lemurs that have been studied Most like the ring-tailed variety live in polygamous groups but there is at least one monogamous lemur the indri, among which the female is also dominant Anthropologist L. I. Pollack of London's University College, watched these tailless, black-and-white primates for over a year and discovered that indri females make their status very clear by occupying the top parts of trees where most of the food is The males occupy the barren lower branches. As with the hyenas only when a female moves on does a male dare to climb up and take some food for himself

By contrast, most other monogamous primates divide the power between the males and females in an arrangement of codominance Patricia Wright a primatologist with the City University of New York was able to observe two such species the titi and night monkeys in Peru's Manu National Park, According to Wright the fe-

styles of both types are very similar. 'The adult male and female never squabble,' she says. "They share everything. The male carries the young about eighty percent of the time. The female has the infant only when she's actually nursing."

Males are still dominant among most group-living primates. Even there, however, females have developed a powerful weapon: the female coalition. Like their human counterparts, they've learned the strength of numbers. 'If one of the infants screams, female vervet monkeys will mob the nearest male,' says Linda Fedigan, who has made long-term observations of the animals both in captivity and in the wild. "So the males tend to stay away from the infants. The female coalition is a good way to counteract males who are larger and can intimidate females individually."

These kinds of discoveries raise broader questions about the evolution of animal and, indirectly, human society. The fundamental question is, Why did female dominance evolve in its various forms?

One insight may be gained by observing animals' mating strategies. According to the theory of sexual selection spelled out by Charles Darwin over a century ago, males grow larger and more dominant so that they can battle other males effectively for females and/or territory with which to woo females. These macho traits theoretically make the males more appealing to females. Animals like the spotted sandpiper are merely practicing the female version of sexual selection.

Ultimately, dominance can best be explained by environmental conditions. The environment shapes mating strategies and other behavior. Female sandpipers, for example, may have developed the ability to lay multiple clutches of eggs as a way of combating egg loss to predators. For the good of the species. Oring argues, it is better for the female spotted sandpiper to confine herself to laying eggs rather than caring for her young, because the males can do the latter as well as she can.

Like the sandpiper, the hyenas that Tilson studies have had much of their behavior shaped in response to environmental influences. Female dominance among hyenas, Tilson suggests, is a response to the species' need to survive. Hyenas depend on animals they kill or carcasses they find for their food. Competition for the available food can be fierce, and hyena pups might not survive if their mother couldn't assure them a share of each kill.

And among titi and night monkeys the high degree of male interest in the young, as Wright stresses, is ultimately to the male's advantage. Most of the time, the females are either pregnant or lactating—two very costly activities in terms of energy expended. By caring for the young, the male does his part to improve his offspring's chance of survival. Thus he ensures that his own genes will be carried into posterity.

Jolly's discovery of female dominance among the lemur societies of Madagascar, where they have been isolated from outside influences for hundreds of millions of years, has raised another question. Since lemurs are among the most primitive of primates, their social structure lends some credence to the theory that female dominance may have been the original condition of primates. If that's true, why are females dominant or codominant in some species of animals and subordinate among others? Or, as Hrdy asks, why haven't more females evolved dominance?

Again, it is probably a matter of the environmental conditions. Hrdy notes, for example, that whereas most male langur apes collect females in harems, a few Old World monkeys have become monogamous "recently" (within the past few thousand years). Those monogamous species (*nouveaux monogames*, she calls them) may have been affected by the intense pressure of human hunters. It was just too dangerous to live or travel in large groups. And among monogamous species in which there's less pressure among males to do battle, both sexes are a pretty even match in overall size. There is one notable exception to this generalization: *Homo sapiens*.

Given this kind of evolutionary past, what kind of destiny does our biology offer? No one dares to make a prediction, but as Hrdy notes, "There is no evidence in the primate record to justify the old sexual stereotype about passive females."

Indeed, according to John Money, professor of medical psychology at Johns Hopkins University School of Medicine, both male and female patterns are coded into the brain of every animal from its earliest stages, and either pattern may emerge in a species as a whole or in certain individuals. "Nature has this way of laying *everything* down,' Money says. "Both male and female schemata are in the brain."

Money stresses that among *Homo sapiens* dominance is not an exclusively male trait nor does it manifest itself in only one way. "Females are far more ferocious than males in protecting their infants, and males are often more ferocious in defending their territory," he says. "And when it comes to fighting over a mate, there's no difference. Murders over jealousy are just as common among women as among men."

Simply being male is no guarantee of being dominant, argues Money. It's easy enough to find instances where the supposed male-dominance trait "goes kaplooey" as he puts it. "Some males just don't get it," he continues. How many of them are there? No one knows. "Nobody's ever done a head count or a serious study of henpecked husbands."

So if our evolutionary female ancestors were dominant in primitive society, it is plausible that our human female descendants could govern society. The potential apparently exists. As Hrdy notes, "The evolution of dominant females doesn't defy gravity or any natural law."

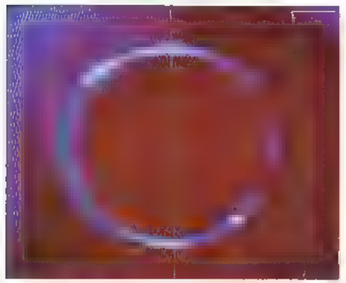
From a maelstrom of electrons and positrons is born the

ULTIMATE X RAY

BY RICHARD WOLKOMIR

Suspended in the air a human heart hangs beating It is translucent a laser-generated phantasm. The surgeons walking slowly around it can ponder every detail. When they come to operate on the heart they are watching, they will know precisely where to place their instruments

Years will pass before such a scene is a reality. But work on real-time 3-D holograms of living bodies has already begun in an underground synchrotron or atom smasher, at Cornell University It is just one among hundreds of uses to which scientists are putting a new research tool With it they can study anything from individual atoms trading electrons with their neighbors to Earth's white hot core to the dance of proteins



A technician mans the massive control panel of Cornell's synchrotron facility (right) The control room's spectrum analyzer (above) shows when the X-ray beam is perfectly tuned

PHOTOGRAPHS BY DAN McCOY

"Physicists, geologists, biochemists, crystallographers, and scientists from scores of other persuasions propose experiments to a CHESS panel."

in the membrane of an individual cell. As one physicist puts it, "This is one of the hottest things going on in science today."

This new tool is the same one that a dentist uses to check your teeth: X rays. A dentist's X-ray machine radiates in all directions at a fraction of a watt; X rays come off the synchrotron with an intensity that is hundreds of thousands of times stronger. These rays are not diffuse. They are concentrated in a flat beam no wider than an inch-and-a-half-wide leather belt. The beams are so potent they have set fire to film and other materials.

Until recently the high-energy physicists who use synchrotrons to study quarks and other subatomic fauna dismissed this radiation as so much waste to be discarded like table scraps. No more. "This installation is an example of old-fashioned Yankee thrift applied to science," says physicist Boris Batterman, who looks like a peppy Humphrey Bogart and heads the Cornell High-Energy Synchrotron Source. Known by its acronym, CHESS, this facility puts those atomic scraps to good use.

In operation only since 1981, Batterman's facility is one of just a handful of synchrotron sources in the world, and of that select group its X rays are the most powerful. Its atom-smashing process begins with a cannonlike linear accelerator that generates electrons and positrons and then sprays them into the synchrotron itself, a tube running through a circular tunnel measuring a half mile around. The particles enter the synchrotron at an energy level of 150 million electron volts.

Electromagnets wrapped around the synchrotron tube steer the particles in a circular path. The particles travel in tight bunches the diameter of a sewing needle—the negatively charged electrons whizzing counterclockwise around the ring, the positively charged positrons, clockwise.

Built into the synchrotron ring are radio-frequency (RF) cavities that create waves of electromagnetic energy. When the speeding particles hit these waves, the electrons and positrons receive a forward kick, much as a surfer shoots forward as his board rides a breaker. In a split second the particles accelerate to as much as 8 *billion* electron volts. Electromagnets then shunt them through a connecting tube into the laboratory's third main part, the Cornell Electron Storage Ring, or CESR (pronounced *Caesar*). CESR is a tube that circles the tunnel next to the synchrotron tube.

CHESS director Boris Batterman and his lead telephone booths (above). Special radiation-sensitive badges, dosimeters (above left), are required gear at the facility's X-ray ports (left).

Here, in a high vacuum the electrons and positrons coast in opposite directions for several hours colliding and recolliding for the benefit of the physicists in the control room upstairs Like racing cars skidding as they round turns the particles radiate energy as they circle CESR To keep their particles up to speed, physicists must constantly replace this lost synchrotron radiation with kicks from the RF cavities They do not like the resulting electric bills

Until 1981 the radiation simply went into the metal walls of the storage ring, generating heat that in turn required an elaborate water cooling system to dissipate it Then Batterman and his team backed by funds from the National Science Foundation, attached the CHESS facility to the synchrotron tunnel and began to tap at least a portion of this energy for research

The facility is buried in a corner of the Cornell campus devoted to athletics, in a blind brick stub of a building across from the tennis bubble A discreet sign tucked away in an alcove says WILSON SYNCHROTRON LABORATORY No sign says CHESS

Wilson Laboratory's top floor the fifth is also at the street level All other floors are underground The entrance to the building is an elevator with nowhere to go but down CHESS is in the basement, next to the synchrotron tunnel. "Look at this," says Don Bilderback, a staff physicist at CHESS He holds up a strip of lead an eighth of an inch thick Burned in its center is a hole you could poke your index finger through "The beam that did this came out of the synchrotron; you can imagine what it would do if your dentist used it to check your teeth for cavities," says Bilderback

An accelerator like this is one of the most complicated instruments man has created It's amazing that it breaks down as infrequently as it does," Bilderback comments later as he and a visitor take a rare stroll through the accelerator tunnel

The intense radiation usually makes the regions off limits to humans but the beam is turned off now while technicians fix a vacuum leak in one of the RF cavities With the beam down, Bilderback and his visitor wander through the tunnel containing CESR and the synchrotron

Every inch of the two tubes is encrusted with vacuum pumps cables water pipes electromagnets, and RF cavities All of these must work perfectly, or the whizzing particle bunches inside will weaken or wobble When that happens the facility must shut down while technicians enter it to hunt for the problem, sometimes patrolling the tunnel on bicycles

To create CHESS, engineers have cut open CESR and attached straight pipes at a tangent to the curving ring X rays travel in straight lines; so every time a particle bunch comes whipping around the ring at nearly the speed of light, streaming radiation, a portion of its X ray photons shoot down the pipe and into the CHESS facility

"It's like a railroad train speeding around a circular track at night its headlight is the X ray beam," says physicist Bilderback. Whenever it passes one of our beamlines, it shines its headlight in. We make use of the light"

Unlike a headlight beam, however this light is lethal That makes CHESS touchy to operate Researchers must wear dosimeters radiation sensitive badges which CHESS staff members constantly double-check to guard against accidental radiation exposure They set up their experiments in heavily shielded cabinets headtelephone booths situated along the beam pipes To get into their booths, the scientists must remove a special key from a central control panel. Several layers of such precautions make accidents caused by absentmindedness impossible My own laboratory on the other side of the campus is more dangerous than CHESS," explains Batterman "My car is more dangerous

Physicists, geologists, biochemists crystallographers and scientists from scores of other persuasions propose experiments to a panel of experts who allot the CHESS time slots Uses for the sizzling X rays are limited only by the imaginations of the researchers who use them

Because they can do work that can be done nowhere else on Earth but at a synchrotron source like CHESS, scientists from across the country will wait months for a crack at using the facility And when their slot in the schedule finally opens up they' work day and night on their experiments They take catnaps on the couch in the tiny lounge or rest cuddled against the synchrotron's lead shielding. The "sleeping bag syndrome" researchers call it

A favorite technique among the scientists is EXAFS, which is an acronym for Extended X-ray Absorption Fine Structure Despite the mind-twisting name this technique "is exciting because it's so simple The X ray specimen could be just a dot" according to Batterman

When an X ray hits an atom he explains, it usually knocks out electrons Each electron adheres to the atom with an energy that depends on its distance from the nucleus and on the other atoms nearby By adjusting the X ray's beam strength, scientists can tune it for a particular atom they wish to study An EXAFS experimenter would mount his sample in front of the X-ray beam port tune the beam to the atom in question, and position an electron counter behind the sample By studying how the sample absorbs energy from the X ray the researcher can determine the distance between the sample's atoms as well as identify the types of atoms surrounding the one that interests him "In other words you can see the environment of a particular type of atom," says Batterman

Joe Wong a General Electric physical chemist, uses EXAFS techniques at CHESS to take a close look at coal with the ultimate goal of developing clean, high efficiency techniques for processing it. This

CONTINUED ON PAGE 96

"Here's a feature you're really going to like. It's a full-service multiband receiver with digital readout and optional snooze alarm."

FICTION

Kid the Flash is one of the great rock and rollers of his time. But success is killing him

WIRED

BY DAVID BISCHOFF

PAINTING BY MICHEL HENRICOT

The Kid's in his dressing room, spitting up sparks. Spudzek stalks the room, popping pills as if they were M&M's. "Jesus!"

He slams his hand into the videophone again. "Where's the fuckin' doctor? The show's only an hour away!"

Blood drips onto my hand. The Kid rolls away from the trash can. His shiny blouse, mottled by the vomit stain, catches light flashes it back in my face.

A smoke wisp curls into my eyes. I can smell the wrongness.

"Can't, asshole," he mutters. He tosses those famous frizzled locks, all tangled in teen dreams. "I'll be okay."

"Like hell." The afterimages of those sparks from the Kid's implants are like black holes in my vision. I put a pillow under his head, wipe sweat from his forehead. "What did she do to you?"

He coughs. Gears mesh. Crank of flesh. "Vampire Fire." He sneers. The Kid hates that song. His fans love it. His pulse is still strong and steady.

"Christ, Ellerway."

Yeah, well, this chick, she sucks electricity. God, what a day! Need a new power pack, I think.

I shake my head. "You didn't do this when Simone was around, Ellerway."

"Fuck her." He clamps his mouth shut, punk hard.

I look up at the rumpled Spudzek. "How come you didn't at least have a medmech around? I know they're expensive, but shit, Flash is the show."

"Don't you challenge my judgment! Ever! That's not part of the deal here. I'm doing my job. I can't help it if the Kid goes out and humps some AC/DC before the biggest concert of his career."

"You're just a cheap bastard! Serve you right if we gotta cancel."

Cancel! Spud's face turns bright red. "You ain't gonna cancel. I got a lot of money wrapped up in this gig."

Spud doesn't, and we know it, but he likes his drama, and we let him keep it. "Ellerway will be all right," I say. "Probably just shorted out the voice augmenter. The medmech will have a spare. We can do the show, but Ellerway might need a long rest afterward. Right, Ellerway?" I punch his shoulder lightly.

"Yeah. Capp. How about a drink?"

He tries to get up, but I keep him down. "You'll get all you need soon as we get you fixed up."

The medmech storms in, and a regular doctor rushes in behind him, wheeling a whole lab's worth of equipment, flashing needles, long spirals of plastic tubing, and packets of plasma alongside gleaming racks of metallic odds and ends.

And wires.

There's a moment of freshly fear in Ellerway's eyes.

"Look. You'll be fine," I whisper. "Pretty soon we do what you want. That's what we're after."

He looks up at me and says, "Hell, I want the women and the booze and the drugs."

He smiles and lays his head back.

I take off.

I don't want to see the knives go into him.

He wasn't Kid the Flash when I first saw him perform.

Just the lead singer in a penny-ante synthasock group still using outdated comsynths and Jap guitars. Young, all of them, doing a Monday night in a buzzclub-off of M street in D.C., full of pubescent power and not a whole lot else. I was curious. I'd known his mother . . . real well. I'd heard he had a group. I was pretty burned out, what with thirty years of laying my fingers on lead guitars with almost as many groups. I was with the Dying Ones then, which about says it. The masks of surgery keep your face and body young these days but don't do shit for your soul. Fifty years old. Lots of experience. No money. And to think that I had originally learned classical guitar.

I sat with just a Heineken for company while the band chugged and jerked. Same old rock and synth card deck reshuffled. But Ellerway . . . Ellerway had something, oh, yes he did, and I sat there listening and watching him and didn't touch my beer, which was damned strange for a man who takes an antiatrophy shot every week.

> *"It's the Kid they really want to see. Well, I only want the money. Hell, anybody can understand that. Power? Popularity? Half the world would kill to be where I am now."*

Cocaine-scrawny, he had just a thatch of hair, blond and scruffy. He was seventeen years old. Tattered jeans and a faded corduroy jacket with patches hung loosely around his bare skin and prominent ribs. A red silk scarf was tied around his neck and the cord of an ancient Vocoder mike wound round his right arm like an emaciated snake.

His music was in his eyes. His enunciation was precise. His words snuck around the songs and took chunks out of them, spitting them back into the outwash. He used the Vocoder wonderfully. A flick of his fingers to a key and his voice seemed to sprout metallic wings.

There were brief moments of perfect metal-flesh mesh, power and blood sneaking through the songs. He had no stage presence, but he had the raw stuff.

The set ended. The bouncers wheeled out the basket cases and booted the attachers who had zoned out on their wires. The druggers capped and wanted more, so Zonk did an old Ultravox tune. I Want to Be a Machine.

The band sort of limped away backstage. I asked the bartender if he could arrange a quick meeting for me with Zonk's lead singer.

Before my beer was a quarter gone, Tom Ellerway was beside me, trying to be cool but sucking down a double whiskey damned fast.

"You remember Ultravox, huh?"

His smile twitched. "I inherited a nice vinyl collection from the Sixties, Seventies, and Eighties."

"Got some of my stuff?"

"I think so."

I chuckled. "I sure hope you don't have the clinkers."

"A few. How 'bout 'Boogie Sugar Baby' with the Viber Hots."

I dropped my cigarette in my beer and glared at him. "But . . . wasn't even—"

"Calvin Hodges' guitars." He got a smug smile on his face.

"Not many people knew I was Calvin Hodges."

"You can disco all you want, but if you're a rocker, it shows."

I ordered another round. We shot the musical shit.

Then, in the midst of a sentence, he backed off with an odd look in his eyes. "Crap. What am I talking to Jim Capp about music for? You know it all. You've been around forever and you're surviving."

I shook my head. "I can't change, Ellerway. I'll just keep playing. Always one more set."

He tensed. "How'd you like our set?"

"Your band's okay."

I could see him cringe; so I stuck the rest in real quick. "But I think you're pretty decent."

He bit his lip a moment. "Yeah?"

I patted him on the shoulder. "Yes, indeed. Look, let's you and I get a doggie bag of this poison and head over to the Sheraton. I got some crystals I want you to hear. We can talk."

He smiled. Then suddenly his pale-green eyes got stony and he said, "Hey, wait a minute. You don't wanna—"

I chuckled and knocked off the rest of my whiskey. "Hell no, Ellerway. I'm into sheep now, haven't you heard? Bring some of your band, if you want."

He frowned, embarrassed, but I grinned at him, and it was okay.

I checked my equipment a couple of times that day, but I check it again. They have an opaque light curtain around the stage so that the crowd can't see me and I can't see them.

I hear them, though. I hear the gurgles and the slurps and the crackles of electricity as the wires are plugged in. I hear the screams and the calls, the ocean of jabbering voices.

It's the year 1996, but it ain't the Lord's

no more. I've lusted after this all my life. Top crystal on the charts. The most popular concert draw in the world. Playing the biggest arena, here in Kansas City, with the world plugged in and knowing who I am. Jim Capp tearing their heads apart with his stinging ax.

Except it's the Kid they really want to see. Well right now I only want the money. Hell anybody can understand that, right? Power? Popularity? Ego trips? Sure. Half the world would kill to be where I am now.

Yeah.

So I check my Gibson again, just to be sure. Neurosis. I won't let the roadies touch it. Nobody touches it but me. My souped-up Stradivarius. I strap it on, open some electricity, and hammer out a power chord. It rings and echoes through the auditorium, like the hammer of Thor.

The crowd is suddenly still and quiet.

I let the resonance swirl, knowing the sound man has damped me down. Cheers. I look up. All the technicians and roadies are staring at me. I grin back and take out a cigarette.

Then Spudzel comes toward me. "What the hell do you think you're doing?"

I blow some smoke in his face. "Just teasing them."

"Look. We might have to delay. And you're working them up? We won't get out of here alive." He uncaps a bottle of Maalox and takes a sip. Spudzel hasn't had an ulcer in years, but he's still got the habit.

"Always a delay," I say, striding away. "They'll wait. They always do."

He puppy-dogs my tracks. "Jesus, I'm so worried I think my heart's going to fall out, Jim." He licks Maalox off his lips. "You don't know—"

I look away. "He'll be okay."

"Just as long as he stands up and sings a little. I already got some incredible power going through this hall. Those kids are gonna think a burp and a fart is Johann Sebastian Bach."

"I need a drink."

"There's plenty in the reception room."

"And get stuck answering the critics? 'Oh Mr. Capp. Why did you wait so long—' Is mimic a typical question? 'Is Tom Ellerway the Lennon to your McCartney Jim?' Blow it, Spud."

"Hey, that's part of what you pay me for. Public relations. They're the people who talk to the fans."

"And mouth crap like that review of 'Love and Horror' last week in the *Stone*. A white bread sandwich with a smear of caviar." Spud, I don't want to go in there and face the *truth*. So why don't you just go in there, sneak me out a bottle, and I'll go and put on my stuff."

He shrugs wearily.

I wait outside the wall-to-wall couch while Spud hops over to the table stocked with food and drink. Folks in there seem too occupied with themselves to notice I'm outside peering in, amused at their stupid outfits and behavior.

Then I get unamused fast.

There's this woman, well-dressed daintily holding a glass of champagne and chatting brightly with a man in dark glasses.

Spud elbows his way out, carrying a bottle of Chivas Regal with him.

"Here you go, Jim. Sure wish I could have some of that."

I point past him. "What the hell is that bitch doing here?"

"Who?"

"Hardesty." My finger shakes. "Did you invite her back here?"

"I—uhm—Capp—she's an important person."

"She's the devil's asshole is what she is, Spud. I want no involvement with her."

"She owns half the industry. C'mon be a realist, Capp."

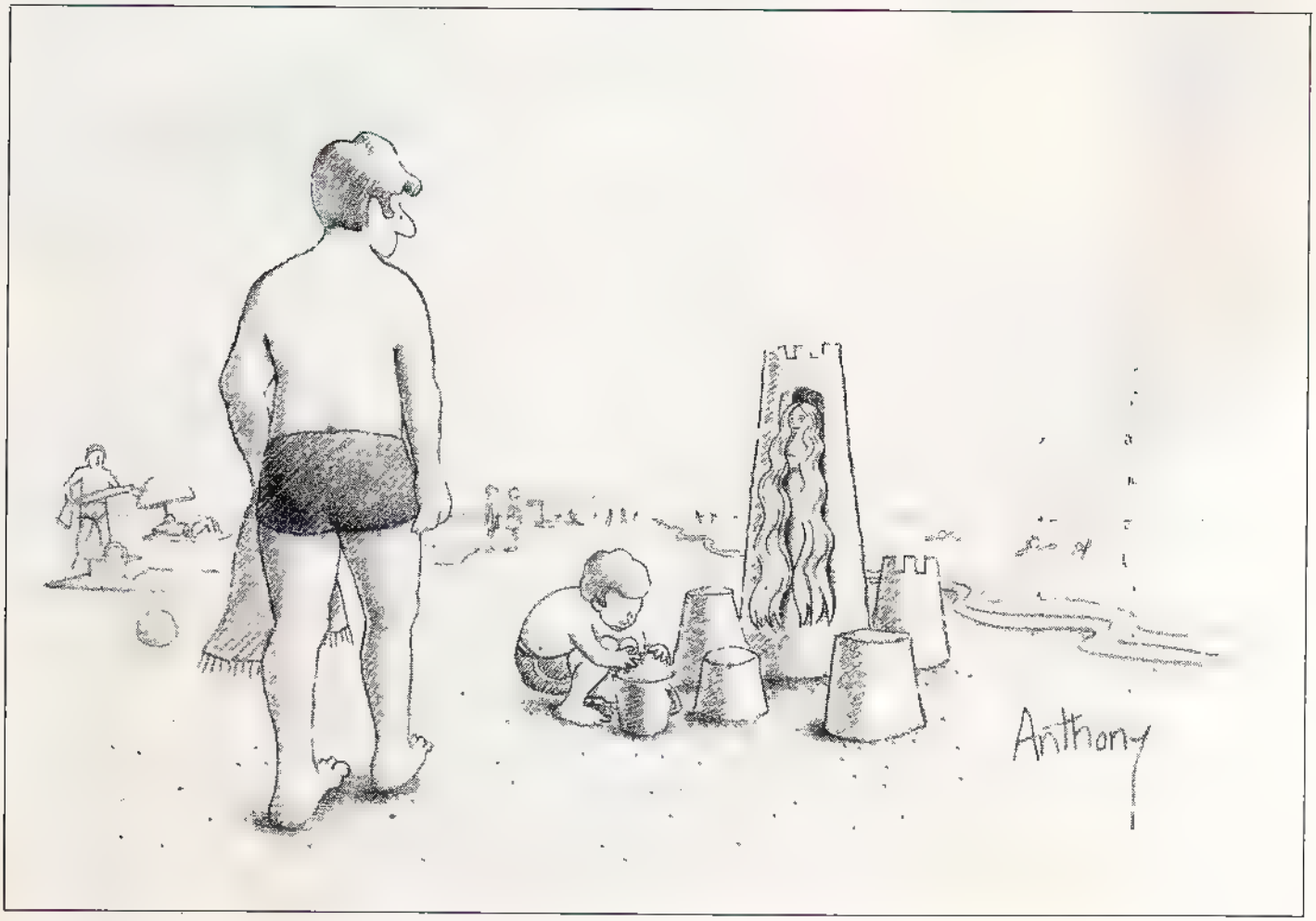
"You go and tell her to get the *fuck* out of here or I will. I've dealt with her before. I'm still taking four showers a day. I don't want to see her at the show."

"Yeah. Sure, Jim."

I nod and turn down the hallway.

Above me buzzes power I can almost smell. The lightning inside the kids.

In my Vermont cabin
In winter
I sat with Ellerway



Outside was snow. Inside was a wood fire, a bottle of brandy, Albioni's "Adagio in G Minor" in the crystal deck, along with Handel and Vivaldi, a collection of baroque.

Staff paper lay all around us, with splotchy notes and G clefs and other stuff I hadn't used in years.

The last chords of the Adagio whispered away like your mother's last breath.

After a long moment, Ellerway said, "Capp. I've been thinking."

He liked it here in my piece of the past, my nest of comfort. Quite a change from his city life.

A deep silence slid between us. Outside, the wind and the snow embraced the cabin with sighs and creaks. The fire burned bright and fierce with a gust of air squeezing through the flue.

"Tell me, Kid."

"What's music?"

"Bread and butter. All that noise bought me this piece of quiet."

"Why has rock survived?"

I shrugged.

The Kid shook his head bleakly and said softly, "I think the reason you play rock, Capp, is because it's ringing through you just like blood.'

"'I Got the Music in Me,' Kik Dee, 1976." Glibly.

He got up. "I'm going to bed."

'Hey, sorry to offend, Tom."

He wobbled. "We stumble around with all kinds of wires coming out of us, and where do we stick them? Up our asses."

'I'm listening.'

He started radiating intensity. "Brain, Capp. Nervous system. Pulse. Beat. Rhythm. Frequency. Zeitgeist."

'Zeitgeist?'

'Jung. Spirit of the times. Collective unconscious, like that."

"Oh. Yeah."

"Okay. Each one of us is a complicated bastard. I mean, just when I decide I need to take a piss, an electrochemical storm is going on all through me. Chemicals from glands, from vitamins, from all that junk that we stick in our faces. It's all going on inside us all the time.

And the brain, a labyrinth of hallways. And what's echoing down those hallways? Electricity and chemical reactions, all pulsing to their particular beats. Inside we're all rhythm and melody and dissonance and harmony and adagio and allegro. And our hearts and souls are rapping out the backbeat, and we dance our lives toward death. Each of us is music.

'And some of us can let it out?'

'Sure! But it's more than that. We're lonely SOBs, Capp, and when music comes inside us from others that somehow aligns with or changes or adds to our own music, it's . . . it's like knowing that somebody is there. You're not alone!'

'And rock?"

'It adds the ingredients of electricity, power, just like in our heads. We're all affected by what goes on around us. What's been the main change in the last hundred and fifty years? Technology. The sounds of the city. You see what I'm trying to say?'

'I think so.'

'Now, all this is damned imperfect. But what would happen if somebody could truly communicate the music in his head? The emotions, the thought structures of being. The attachers are close, but it's too much like direct electrical stimulus. There's got to be pain and ecstasy and grief and love and anger. It's all there in rock. Capp. We just don't have the right instruments.

"Suggestions?

"I think so. We've taken the raw human voice, amplified it, phased it, and Velveetaed it. But all from outside. What if we started from the inside? Electrochemical music. Almost direct mind-to-mind contact because of analogous processes."

"So what would this be? Sort of directly connecting yourself to the instruments?'

"Yes. Surgically. They've already been using it here and there. Implants. Some Japanese groups are experimenting with it. It's going to spread. Question is, Does anybody really know what they're doing?"

> *'I catch the bass line on a down flow and lick a long slide up my E string. The power waits hungrily at the end. I let it eat up the crowd's ears and zoom about like a jet.'*

"Are you crazy? No matter how much I love my guitar, I still gotta put it down sometimes.'

He shook his head adamantly. "You can't put down the music. It's part of you. This way, it just comes out better."

I thought about the music Ellerway and I were making with Benny the drummer. I'd brought in, and how this was maybe my last chance to hit the big and win the teddy bear. I thought about the years of desperation and frustration, the busted marriage and scarred friendships, the groveling and the pride. I thought about the snickers behind my back.

Okay, Ellerway. I got a guy who I think is going to be Kid the Flash's manager. He can hook us up to the right people. We'll think about it.'

I sat and thought some more for several sips of brandy, and I added, "But there are things Kid the Flash is going to have to do, Ellerway. Compromises. You."

I looked down at him.

He was curled up on the rug, face blank and innocent in the flicker of the firelight.

I went and got a blanket for him and then watched him sleep for a while, listening to the music of his breathing.

In the beginning there is darkness.

And darkness is upon the face of the auditorium, and silence.

And Kid the Flash looks upon the dark and the silence and finds it a bummer.

And Kid the Flash says from the rafters and walls and through the wires and the air, 'Let there be rock!'

And behold, there is rock.

Lightning zigzags down to the stage, exploding flashpots around Benny. Drumsticks flash. Chug of train beat of sex, flutter of hummingbird wing. Push of foot and nudge of switch and the bass notes thrum and pound the bottom of "Vampire Fire."

A spotlight hits me.

I catch the bass line on a down flow and lick a long slide up my E string. The power chord waits hungrily at the end. I let it eat up the crowd's ears as it booms and zooms about like a jet.

I riff out the opening theme on chords, then cut in the repeater, which replays the power chords while I squeeze a Frippish screamer lead line.

I strut a bit, the dance of the lover. My guitar waves out a spectrum of light afterimages, sparkler dazzles, and variegated coruscations as I move from side to side, stroking the strings in the exact manner that will cut in the synthesizer computer's resonances. Layers of guitar unfold like audio flowers.

I have a garden suddenly growing in the air, sprouting from the dirt and fundament of Benny's rhythm section. I grin and stick up my green thumb at the crowd, then slash through the foliage with an erratic, exquisitely timed scythe.

I nod to Benny.

Benny has the muscles of a drummer and shows them bare chested. Male domination made flesh and drums.

I pull a switch on the fret of the Gibson, disconnecting the false back, a painted cardboard model of the instrument. It separates in smoke and thunder.

I make an elaborate show of placing the thin pseudoguitar center stage, upright on supports.

Spears of lasers shoot out and twirl through multicolored smoke.

Holo lines begin to shimmer the guitar. Slowly it grows into human form, rock and roll mutation, light radiating as if from some Renaissance Madonna and child.

I can feel the buzz in the air, taste the electricity as the attachers cut in on the first verse.

"In your furnace eyes I see the dust."

Just a voice, cresting the wave of sound like a solitary surfer amidst the roar. I use the break to slide out my computer picker, slip it on my right hand, tap out the program code.

'Staccato coasts and synchromesh tongues.

Probe on molten wings from Phoenix dust
Through stainless-steel mouths to fleshy lungs.'
Deep, tortured, echoing breath
Vampire Fire."

With a deafening explosion, the holographs cut in engulfing Kid the Flash in illuminating fire.

I cut the picker and my fingers fly over the frets to match the machine-gun notes.

The Kid is resplendent in his robes. He looks good.

He drops to his knees before the squirming audience, his voice winding in their heads. We flow through "Vampire Fire" like a race car.

The medtech has done a fast job on him. New voice-augmenter circuit. New power pack. Ellerway has a hard time getting through airport metal detectors. He had to work out a lot at first to realign his fleshy musculature to compensate for his added weight. But he'd done it, and everything he'd ever said about electrochemical organic music was true. His songs pierce and heal. Light up the insides of your head when they're truly his and not glossed up. The records are just an echo. Live concert is Kid the Flash's forte.

Ellerway stutters out the final words a cappella.

"For when you draw out my love's breath
You suck not on life, but death.
Vampire fire, you consume yourself."

The computers click on the last word.

Slowly building a choir of voices that crest up majestically. I embrace the sound with a few sustained whines wrested from my guitar. The crowd roars.

Ellerway bows his head with dramatic sadness and I slam a few Townshend chords of defiance.

The song is finished.

Ellerway looks up. He walks slowly over to me as the applause swells. He leans toward me to speak. I can see tiny, fresh stitches in his neck that have been carefully covered by makeup. Two drops of blood welled up on the sleek line of his throat. I take my scarf and dab them off.

He shakes back his hair. He stares at the audience and waves. "Tonight's the night. You think you can follow me?"

"What are you talking about?"

He shrugs. His eyes have a faraway haunted look.

"I don't know anymore."

The opening rainbows are forming above us for "Cry Like the Sky." Ellerway strides slowly into a spotlight. He stands there very thin and small against the monstrous gestalt beast of the crowd: the noise, the electricity, the power.

Tom Ellerway, Kid the Flash, opens his shirt, parts the synthetic flesh from his ribs.

He plays the keyboard that's been surgically embedded there, above his heart.

We play.

The first part of the show has been programmed with familiar material. A foundation upon which to build. Totally absorb the audience, then take them elsewhere.

We play well.

Our timing is clean and perfect. Benny throws in a few surprises.

I do an improv from time to time. All sharp as a very professional.

Something, though, is wrong with Ellerway. His performance begins to lack the emotional impact we'd begun with. The audience doesn't seem to care. I do.

I play like a demon. I turn to Ellerway. He stares at me while he sings. It makes me feel creepy.

I slam and I pick and I bang. Just rote stuff. Note for note equivalent to the snazz rock we'd been putting on the crystals.

I'm waiting to break loose on what Ellerway said was going to be his crest tonight. I even goad him with a searing run that drowns him out before the mixmen can pare it down.

Stately we bump out the last of "Twenty-First-Century Shuffle." The lights dim. I put my hand up to stop Benny from the beginning beats of the next tune, "Hard as Rock." My baby. It's got a five minute guitar solo I don't want to ruin.

In the darkness, I tug Ellerway behind the wall of amps. Pale light leaks from their guts, spilling onto us like the luminescence of deep-sea creatures.

Leaning near Ellerway, I shout above the sound of applause.

"Hey man! Where's that charge you were talking about? I thought this was supposed to be your night."

"It'll be there, man. When . . . when it's ready." His eyes are corpselike, his face chalky. I pull my hand away from his shoulder, which is sopping wet. Sweat?

My fingers come away into the ghostly light greasy with blood and oil.

"Jesus!" I look into his eyes again. I knew what they'd done. I storm back onto the stage, grab the mike, and say, "We're going to take fifteen, troops. Technical problem."

I slam the microphone to the floor. The boom crashes through the auditorium like a big fat period to my sentence.

Benny is caught with drumsticks high in the air, feet ready on the pedals of the downbeat machine.

I grab Ellerway by the arm and lead him down the stage steps. Spud is waiting for us at the bottom. "What the hell do you think you're doing, Capp?"

That's the end of the concert, pal. You get Ellerway to a hospital and get him fixed up right. Then we'll talk about getting him back on stage."

Ellerway sags against me in a drugged glaze. "I can do it, Capp. I can do it, damn it. And I will." He looks at me. His eyes kind of flash for an instant, then go cold inside.

"Listen to the Kid. Now you get back there and do your job."

"I told you, you fucker." I grab him and pull his ear real close to my mouth. I begin to shout. "He's going to a hospital. Make the arrangements and the apologies to all concerned. I'm not going to have him drop

"He's unsurpassed in lampblack and yellow oxide but a bit out of his depth in red ocher."

dead up there. I don't know why I ever let him do those operations. *Shit!*"

Spudzel is as white as a dead worm in a rain puddle. "You . . . you can't cancel. There's no provision in the contract."

"What? There's gotta be. The Kid is sick!"

Spudzel is looking away, shivering.

'Spud. What's going on here?' I let go of Ellerway and get a good grip on our manager. "What have you done, Spud?"

He won't look at me.

It all comes to me.

I punch Spud hard in the face.

He goes down blubbering and bleeding, but still conscious.

"I ought to kick your balls into your throat you fuckin'—"

"I . . . I had to, Capp," he moans. "You were in such a goddamned hurry. She was the only game going that could do what you wanted done. I swear it. Jesus, leave me alone."

I want to kill him. "That's not the whole story, is it, man? What happened to you, Spud? What the hell's happened to you in these years?"

He looks at me. All his hardness is back in his eyes. "Same thing as happened to you, chum. And I tell you, if you and the Kid don't get back on the stage quick, she's going to have your butt for breakfast." Suddenly there is defiance in the little man. "I'm sorry that I had hit him."

"Where is she?"

"Sky Suite 4, Capp. Watching the show.'

"You get the kid fixed up best you can. No drugs this time. I'll be back.'

I stomp toward the exit.

A curly-haired bruiser shows me some teeth in a snarl and moves me inside.

The little room, with its window above and facing the seething crowd, is done up elaborately with velvet curtains, plush furniture, and a smooth rug. A shiny silver tea service sits by the side of a high backed padded leather swivel chair.

"Hello, Capp."

"So, Hardesty. You've got your hands on me after all.'

She is still beautiful. Her beauty knocks a bit of the hate from me. "Not so much you, Capp, as your group.'

All the way from groupie to group goddess, eh?'

"The amenities are not necessary. I trust you will soon be returning to the stage, with Mr. Ellerway. We've had to cram in a few videos on the satellite network and they're going to run out in— ' she examined a ring watch—"twelve minutes.

'How much of this do you own?'

All.

And if we don't go back?'

'That, Capp, will be the end of Kid the Flash as an independent entity. You will be all mine, Capp, which would quite please me, I've a few ideas of my own about the group that I think will interest you.'

"And if we do go back?"

"You'll be just mostly mine.' She shrugs and smiles. "So you see, either way, I really don't care."

"You want us to go out there and give a lousy performance, maybe have Ellerway fall flat on his face."

"That would be dramatic. But I don't think it will happen." She is calm and cold, radiating confidence with every bit of floss that coats her blond stack of hair. Her heart is all vinyl; her soul, all crystal. Of course she has other interests these days. Financial ventures that far dwarf music. But music is where she got her start, and it's where she dallies most, delighting in owning us all. She and I had our brushes in the old days. The first had been in a hotel room after a gig. I didn't remember, but she reminded me of it later, when she was on top.

"You don't want it to be too good, do you? That's not your style.'

"Pardon?

"That's why you sicced that little AC DC on Tom." I say, sighing. "And I bet you were even behind the scene with his girl leaving. How'd you manage that, Cynthia?'

"You're paranoid, Capp." But her cool exterior has cracked, and I know I'm right.

It's not enough to play with bucks, is it dear heart? You've got to have souls to bounce about as well. So tell me, are you enjoying the show?

She smiles. "I think it needs more zip in the lighting. Now, if you'll follow my directions, Capp, we can have a real dazzler."

You're a real sweetheart.'

I'm not as bad as you think, Capp."

No,' I say, "you're probably worse."

I sat on my can in the doctor's office, paging through old copies of *Reader's Digest*, waiting for Ellerway's preliminary exam before the refitting could begin.

Dr. Rashone came out, his smock clean and white, wafting with him the alcohol smells of surgery that gave my spine the creepy-crawlies.

His delivery was as well pressed as the cuffs of his no-stat trousers riding fashionably above glossboots. "You're Mr. Capp?'

"You're Rashone, right?" I took his cold hand and pumped it. I gave him my California smile. We relaxed. He sat down.

"Usually, with Mr. Ellerway's age, it's necessary to get parental approval for this kind of thing,' he said.

'Then Tom's okay? He can go ahead with the implants?'

"He's healthy. His system will allow the antirejection treatment. As you know, I'm the only mechosurgeon presently qualified for this sort of extensive electronic enhancement."

You're the only one who will do it for a potential rock star, you mean."

I am intrigued by Tom's desires and notions. He is truly dedicated to his art. I have warned him, however, and will warn you that this is a very new technique. There may be difficulties. There may be subsequent surgical realignments and biomech adjustments from time to time. As the state of the art improves, no doubt we will replace the system. Above all, regular checkups will be necessary. And a qualified biomech maintenance doctor or intern will certainly have to be in attendance whenever Tom chooses to use the instruments, be it in the studio or at a concert."

'Delicate stuff, huh?'

"The instruments? No. I think that for all his health, Tom Ellerway is quite a bit more delicate, actually."

"What was his reaction to that?"

"He seems quite confident of his ability to hold the mechanisms and adapt to them. He's very eager to try them out. Rather like a kid with a bunch of new toys." He scratched at his straight, sharp nose and sighed. "Frankly, though, Mr. Capp, I advised him against all of this.

"You what?

"In our preliminary talk last week, Tom played some tapes for me of what he's been composing. I'm impressed.

"Do you think he won't be able to do his best with his new—uhrn—apparatus?

"It will neither harm nor increase his actual musical abilities. It will merely increase his range. It's like giving a gifted violin player the capacity to play an entire orchestra of instruments while doing his own conducting. Tricks, Mr. Capp. In fact, I'm not sure that this system is capable of the high flown ideals that Tom seems to have for his music. I am merely a biotechnical surgeon.

'He intends to be the best rocker ever. doctor. Something wrong with that?'

"Does he? Well, he will certainly be something to see and hear with all the embeddings we're talking about. But will the audience truly be able to appreciate what he's doing? Or will he merely be a squawking freak to them, a pleasure machine? The key word there, Mr. Capp, is machine. I would not wish Tom, or anybody, that. Frankly, if he were my son, I would not allow it. This is why I ask for parental permission.

"What was Tom's reaction?"

I was getting antsy. We were building our whole act, our whole publicity push around this operation.

The doctor smiled gently. "He told me I was an old goon. I should stick the advice up my ass and the electronic stuff inside him. He'd take care of the rest.'

I nodded. "Sounds like Ellerway.

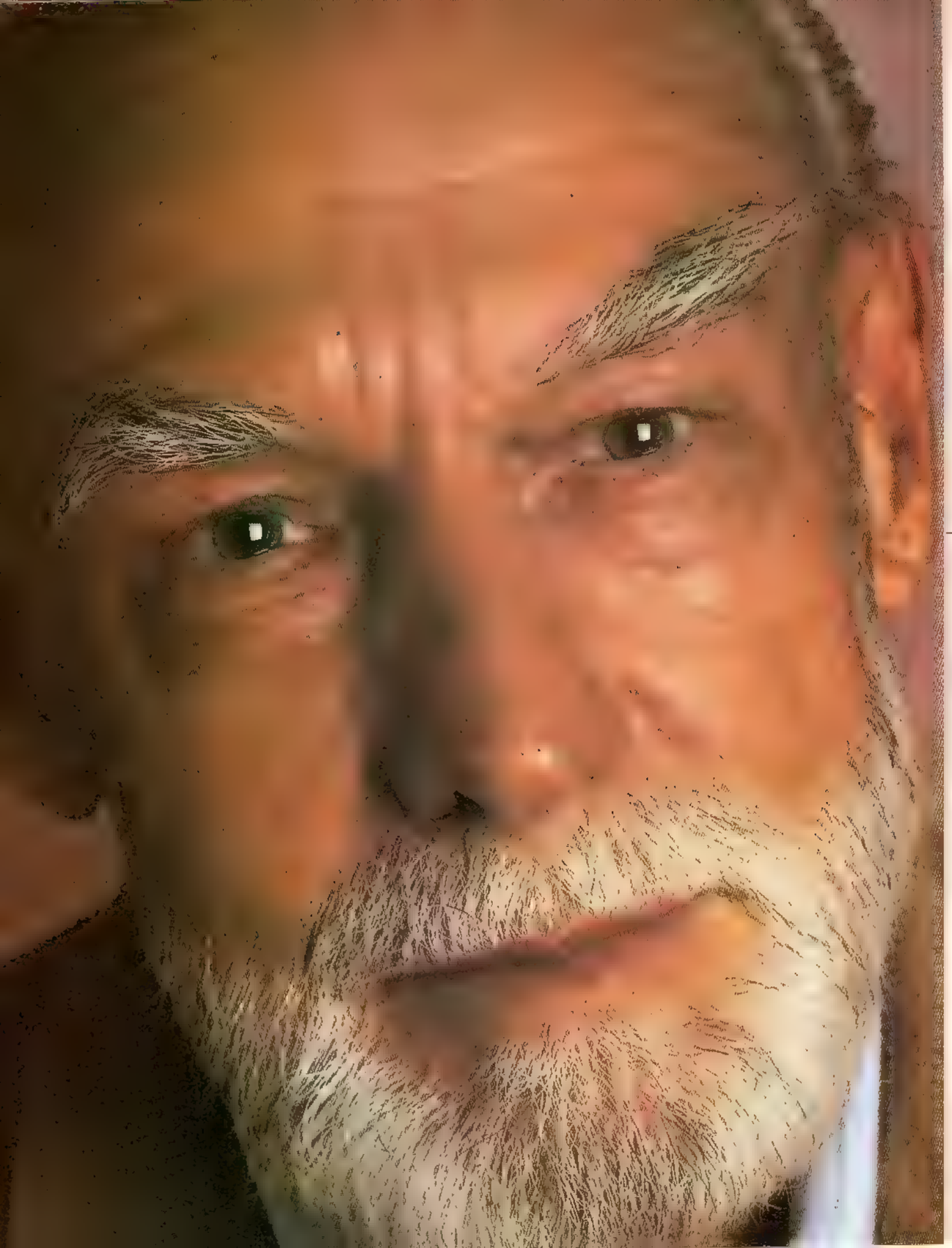
"So I thought that you might like to persuade him not to. He speaks highly of you."

'Me? Hey, it's not for *me* to try and run his life.

"Ah. I see."

I was suddenly cold and uncomfortable.

CONTINUED ON PAGE 82



The bold debunker whose split-brain research galvanized neurophysiology now plans to topple the last great pillar of conventional science

INTERVIEW

ROGER SPERRY

Science was wrong. Its interpretations of man and the world were demeaning and dehumanizing," declares pioneering brain researcher Roger Sperry. "All physical reality, including the human psyche, was reduced to quantum mechanics. The richness, color, and beauty were all lost in mathematical concepts." At sixty-nine the man who shared the 1981 Nobel Prize in medicine and physiology for his famous split-brain studies has turned his attention to battling the materialist legacy of twentieth-century science. This latest assault on orthodoxy comes as no surprise, because Sperry, though shy and reserved by nature, has never been afraid to challenge accepted doctrine. In his 40-year quest to understand the nature of human consciousness, he has overturned more than one cherished belief. Bearded, with bullet eyes capped by gracefully arched brows, Sperry may have been destined to play the part of scientific debunker. As one former colleague notes, Sperry is "constitutionally able to be interested only in critical issues."

Even as a graduate student at Oberlin College, in Oberlin, Ohio, Sperry challenged his distinguished mentor Paul Weiss, who propounded the view that neural connections were determined by experience rather than genetic mechanisms. To test his theory, the young scientist designed an intriguing experiment that involved rotating the eyes of a salamander by 180 degrees. If Weiss's theory that "function precedes form" were correct, the salamander would eventually adjust to seeing the world upside down and alter its behavior accordingly. But the poor salamander never learned to compensate for its distorted vision. Even after hundreds of training trials, it continued to dart in the opposite direction of any lure placed in its tank. Moreover, when Sperry severed the nerve pathways to the eye, the tangled fibers somehow sorted

PHOTOGRAPH BY CHRISTOPHER SPRINGMANN

themselves out, only to reestablish the same "upside-down" connections as before. Neural networks, Sperry concluded, organize themselves independently of the function they ultimately come to perform. Even today, his landmark study is touted by those who believe that basic behavioral patterns of humans and other organisms are heavily influenced by genetic factors.

The way that growing nerve fibers are guided to predetermined connections preoccupied Sperry for the next decade, eventually leading him to postulate that brain cells use "a kind of probing chemical-touch system." His theory—that the nervous system arranges itself according to a chemical code roughly analogous to the color code that governs the wiring of circuits in a telephone receiver—is now considered a keystone of developmental neurobiology. But in the intellectual climate of the early Forties, Sperry's concept of a "hard-wired" brain met strong resistance.

One major opponent of this viewpoint was the eminent neurophysiologist Karl Lashley, whom Sperry worked under at the Yerkes Laboratories of Primate Biology then located in Florida. Lashley's arguments against the specificity of nerve connections stemmed in part from reports about a rare group of patients who had undergone radical brain surgery to stop intractable epilepsy. These people were operated on to sever the corpus callosum, the main nerve cable that connects the cerebral hemispheres.

"At that time the corpus callosum was an enigma," recalls Sperry. "You could cut it completely—two hundred million nerve fibers—and it didn't seem to cause any functional deficit that people noticed. This fit in with a commonly held notion that the brain is characterized by wholesale plasticity and comes out functioning fine no matter how you cut or scramble its nerves."

A decade of animal studies soon dispelled many false ideas about the corpus callosum, including Lashley's assertion that it was little more than a mechanical prop to stop the hemispheres from sagging. Once this connection was broken, it was as if two minds resided in the one brain. Each half of the cerebrum was capable of learning, remembering, and feeling thoughts completely unknown to the other. To Sperry the conclusion was inescapable. The neural isthmus must be vital for an integrated sense of awareness.

Still greater revelations followed. In 1953 Sperry was appointed Hixon Professor of Psychobiology, at the California Institute of Technology, a post he has held for the last 30 years. Shortly thereafter he launched a series of now-classic studies of split-brain individuals—patients whose corpora callosa had been severed surgically. At first the test results appeared to support the popular contention that the right hemisphere was "mentally retarded" in comparison to the left hemisphere, which had long been recognized as the seat of linguistic abilities. Careful examination, however, altered the picture drastically. For example, a split-brain individual might categorically deny the existence of an object placed out of view in his left hand (sensory information is transmitted from the left hand to the right half of the brain). But if that same subject is given a nonverbal mode of identifying the object, such as feeling with his left hand for its match in a collection of items, he will invariably make the correct choice despite frequent protestations that he is merely guessing.

Clearly the right brain was neither dumb nor devoid of consciousness, as early authorities had insisted. It just lacked the words to inform investigators of its hidden talents. As Sperry disciple Michael Gazzaniga recalls: "No one was prepared for the riveting experience of observing a split-brain patient generating integrated activities with the mute right hemisphere that the language-dominant left hemisphere was unable to describe or comprehend."

Interestingly, the left hemisphere often proved all too willing to comment on matters it knew nothing about. During one routine test of a female patient's ability to make visual discriminations, Sperry replaced a slide of a household object with one showing a nude woman. Using a special apparatus, called a tachistoscope, he was able to project the picture only to her right hemisphere. The arresting stimulus triggered a sudden change of expression and her face reddened as she laughed nervously. "What's so funny?" Sperry asked. Forced to rationalize an embarrassed response to something it had not seen, her left hemisphere replied, "I don't know, nothing . . . oh, that funny machine!"

From this experiment and hundreds more like it, Sperry and his colleagues gained powerful insights into the dual nature of human consciousness. Today it is widely recognized that the left hemisphere is primarily verbal, logical, and sequential. The right side is viewed as more intuitive and emotional, specializing in visual-spatial problem solving and other situations in which a single impression or mental image is worth a thousand words.

"As evolution progresses, combining the atomic building blocks into ever-newer, more complex compounds, new properties emerge. In the brain, too, you have these nested hierarchies."

For the most part, Sperry is glad that this distinction has entered the mainstream of public knowledge. In his Nobel lecture, he noted that split-brain studies have led to a better appreciation of nonverbal forms of intelligence and increased understanding of "the inherent individuality in the structure of human intellect." He also feels his research has helped to underscore the need for educational tests and policies to selectively identify, accommodate, and serve the differentially specialized forms of individual intellectual potential.

Still he can't help being amused by the cult following that the theory attracted in the Seventies, especially among philosophers, psychologists, and pedagogues. Sperry realizes that it's easy to become intoxicated by the implications of the bicameral mind. He treated the subject with characteristic dry wit when he accepted the 1979 Ralph Gerard Prize of the Society for Neuroscience. "The great pleasure and feeling in my right brain is more than my left brain can find the words to tell you."

The achievements of Sperry's left brain earned him numerous other awards and honors before the Nobel Prize, including the 1979 Albert Lasker Award, the highest distinction in American medicine. But as a sculptor and self-described dabbler in artistic pursuits, including folk dancing, ceramics, and figure drawing, he hasn't neglected development of his right brain either. As a child growing up in rural Connecticut, he also acquired a passion for wildlife that has persisted to this day. Outdoor activities—camping, fishing, fossil hunting—now dominate what leisure time he can find in his busy schedule.

An intensely private man who prefers the solace of nature to life in the limelight, Sperry conveniently vanished from sight at the time of the Nobel announcement. While his Pasadena office struggled to handle the deluge of calls and telegrams that poured in from well wishers all over the world, he and his wife snorkeled along the beaches of Baja California, returning only after the hoopla had subsided.

When not retreating to the wilderness, Sperry spends most of his quiet moments exploring the broader ramifications of his revised view of consciousness, applying his knowledge of individual awareness to global phenomena. He is, in effect, superimposing the bicameral mind on the collective consciousness of society, attempting to reconcile two schools of thought: the reductionist view of the scientific materialist, who adopts the left brain's strategy of chopping up reality into fragments, and the humanistic view of the philosopher who favors the right brain's holistic perspective, which incorporates emotions, ethics, and other complex values.

Just as the left hemisphere was once thought to dominate human consciousness, Sperry feels that its cultural counterpart—reductionism—has been given too much weight in society. Still the zealous debunker of his youth, he is quietly chipping away at this last great pillar of modern

science. And when it finally topples, he intends to lay the foundations for a much more integrated world view of science one that encompasses the concerns of the humanist and the reductionist under one intellectual umbrella. In his recently published book, *Science and Moral Priority* Sperry explains how these revisions could qualify science for a higher role in society as a partner with religion in the quest for an ultimate ethical and moral frame of reference. Changes in our social priorities he believes, are a prime requisite for civilization's survival.

Sperry talked about his views with science writer Yvonne Baskin in his office in Caltech's Norman Church Laboratory.

Omni: Aren't ethics and moral values pretty far afield for a brain scientist?

Sperry: In some ways, but actually they're a natural follow-up to something I came upon in the mid-Sixties—a modified concept of the mind-brain relation. It's common practice in science to follow up on the most promising leads opened by any new discovery, and these human-value implications seemed to be far and away the most important.

Omni: Granted, human values are important but don't they take you way outside the bounds of science?

Sperry: Well, my scientific colleagues sometimes think that I've gone off the deep end or something, but I don't look at it that way. I view it more as a shift to a new scientific area that's now developing. You see, according to our new views of consciousness, ethical and moral values become a very legitimate part of brain science. They're no longer conceived to be reducible to brain physiology. Instead we now see that subjective values themselves exert powerful causal influence in brain function and behavior. They're universal determinants in all human decision making, and they're actually the most powerful causal control forces now shaping world events. No other causal system with which science now concerns itself—earthquakes, chemical reactions, magnetic fields, you name it—is of more critical importance in determining our future.

Omni: Your research defined with new clarity the different but complementary roles of the right and left sides of the brain. A lot of follow-up work remains to be done on the way the two hemispheres interact and how the dominance of the right or left hemisphere of the brain in an individual correlates with sex, musical or mathematical ability, creativity, occupational preferences, right- or left-handedness, and so on. Doesn't this work interest you anymore?

Sperry: Yes, of course, it's all interesting and important science. But you always have to ask, "What difference does it make?" Or better, "What difference is it going to make ten years from now?" You look around at all the looming threats of global disaster and the declining quality of life, and wonder, "What difference will it make if we suc-

ceed in improving educational policies a little or neurological diagnoses, or our understanding of right-left differences, or details of hemispheric interaction?"

Then, by contrast, think what even a very slight shift of values would do in the delicate balance of opposing positions in the abortion controversy for example, or in various environmental matters, or other global issues We're talking here about hundreds of thousands of lives, pro or con, about the kind of world we and our grandchildren will live in if they live at all and the kind of laws we're governed by When you see your science having direct and compelling implications in these areas, it's hard to turn away and go back to more laboratory experiments especially when you see in this new path the one humane means for getting us out of our current global straits

Omni: But doesn't science in its traditional role provide hope for concrete technical solutions to many of today's problems?

Sperry: Technological answers by themselves, in the absence of population controls, just put us deeper and deeper in a self-feeding, vicious spiral of mounting population pollution, energy and resource demands and so on

Omni: The best way to break this spiral is to change man's sense of values—to evolve a new global ethic or theology?

Sperry: That's the most humane way A nuclear holocaust, global famine, or some other worldwide catastrophe would do it of course, so would just letting things continue as they are But the most painless and reasonable solution presently visible is to change the kinds of values and beliefs we live and govern by. Others agree with this. Lester Brown, of the Worldwatch Institute comes to the same conclusion in his latest book *Building a Sustainable Society* The National Council of Churches sponsored a meeting three years ago at which representatives from different faiths affirmed that what the world needs today is a new religion, a new theology that will promote the values of conservation, renewable energy, and respect for the land.

Think what would happen if the values of conservation, population control, and so on were to be lifted above the level of just wisdom and expedency to become matters of deep religious conviction Imagine if people worldwide believed it to be immoral, even sacrilegious, to pollute, overpopulate, or in any other way degrade the quality of the biosphere for future generations. This is where our changed views of brain and consciousness seem to lead

Omni: But proposing new values is quite different from just scientifically studying already existent values

Sperry: True, but the two are not separate The increased understanding of the origins of our value systems enables us to choose our moral positions more wisely

But this is only part of it The main point is that our recently changed views in mind-brain science radically alter traditional beliefs about the nature of man and the world about the relation of mind to matter, of science to values, about free will and moral responsibility Even beliefs about science are changed, its scope and limitations, its world view concepts of causation, and the relation of science to the human psyche Everything's transformed We come out with a whole new outlook, new beliefs about all that we group together as reality

Omni: Aren't people worried at the thought of changing human values through science and technology?

Sperry: It's not a matter of altering values directly or experimentally it's more a matter of bringing scientific knowledge to bear where values are already in conflict We're still in the early phase of this. It wasn't too many years ago that values were generally considered to be off limits to science

Omni: Let's start at the beginning What was this change in the concepts of consciousness and mind-brain relation that first prompted you to endorse the merging of

> *"Since each side of the surgically divided brain is able to sustain its own conscious volitional system, the question arises, Why don't we perceive of ourselves as two persons?"*

science and ethical and social values?

Sperry: It was the change involved in the so called consciousness, or mental revolution in psychology that took place during the Seventies, a turnabout in the treatment of consciousness Behaviorist principles which had dominated for over half a century, were overturned Psychology suddenly began to treat subjective events—mental images, inner thoughts sensations, feelings ideas, and so on—as factors having a genuine causal role in brain function and behavior. The contents of introspection the whole world of inner experience suddenly became accepted as elements that could influence physical and chemical events in the brain, they were no longer treated as passive, noncausal aspects or even as nonexistent ones

Omni: What you're saying is that neuroscientists previously found it difficult to see how the sequence of brain events could ever be influenced by anything other than strictly material, physical and chemical agents. Scientists believed that any step in the process must have physical cause

Sperry: Exactly That was the view accepted by psychologists as well and the farther neuroscience advanced the more convincing their arguments seemed It appeared that a complete account of brain function and, for that matter, all of nature could be given in purely material physicochemical terms without any need to refer to conscious mental, or vital forces of any kind Science claimed it had absolutely no use for consciousness since consciousness couldn't do anything in the brain and didn't change anything. There was no need for it in a causal explanation. The progress of brain science toward an ultimate physicochemical description of behavior seemed to leave less and less for anything like human dignity moral choice meaning, purpose, and such things that go hand in hand with human values That's what I meant when I said science was demeaning and dehumanizing

Omni: What happened to cause the shift in psychology away from these established behaviorist views?

Sperry: In part the time was right Many things came together that collectively outweighed the old arguments in favor of the new Earlier views had been floating around that came close to the current revised concepts. gestalt and humanistic views in psychology, concepts of phenomenology systems theory tacit knowing, emergence, holism and so on The question is, What happened to change all of this from the status of occasional scattered philosophy and minority science to its present status as the dominant doctrine?

I think it was largely a matter of demonstrating a logical flaw in our seemingly airtight reasoning finding a new different logic that fit more widely and combined earlier threads into a new formula for mind brain interaction Mostly perhaps, it was the introduction of some new ideas about causation applied to the chain of command in brain dynamics. When you talk about causes and causal control, science invariably listens!

The key realization was that the higher levels in brain activity control the lower The higher cerebral properties of mind and consciousness are in command They envelop carry and overwhelm the physicochemical details They call the plays exerting downward control over the march of nerve-impulse traffic. Our new model mentalism puts the mind and mental properties to work and gives them a reason for being and for having evolved in a physical system. It also shows how it's possible for mind to be created out of matter in fetal growth

Omni: How do you define mentalism?

Sperry: Mentalism is contrasted in psychology to behaviorism and materialism it's a doctrine holding that mental events as consciously experienced in the mind determine and explain behavior The mental qualities used to be conceived in nonphysical supernatural terms, but we now view them as the emergent properties of brain processes

Omni: What are emergent properties?

Sperry: *Emergent* is the same as *holistic*, the Greek word for "whole." The properties of the whole are contrasted to those of its parts, the concept encompasses the old maxim that "the whole is greater than and different from, the sum of the parts." As evolution progresses, combining the atomic building blocks into ever newer and more complex compounds and then compounding the compounds, new properties emerge at each step. So you start with the subatomic physical properties and work upward through chemistry, biology, psychology, sociology. In the brain, too, you have these nested hierarchies from subatomic levels upward, with emergent properties at each level and conscious properties at the top.

Omni: How does your shift to this mental stance fit in with the split brain studies?

Sperry: It was a matter of explaining the effects of split brain surgery on conscious experience. We found that each disconnected hemisphere was capable of sustaining its own conscious awareness, each largely oblivious of experiences of the other. The separated hemispheres were able to carry on independently at a fairly high level. They could even perform mutually contradictory tasks at the same time, and each was able to exert its own volitional control and select its own differential preferences.

For example, in a blindfold test for tactual sorting, both hands might search together through a scrambled pile of different-shaped beads. One hand would sort out spheres into an upper tray and cylinders into a lower, while the other hand would do just the reverse. In the process each hemisphere would consciously and voluntarily make decisions opposite to those going on in the partner hemisphere. And neither disconnected hemisphere would seem to know what the other was doing. The vocal left hemisphere could report that it had no clue about the experience in the right hemisphere. Left and right domains of conscious awareness and volition seem to be almost as separate as if they were in two different heads.

Since each side of the surgically divided brain is able to sustain its own conscious volitional system in this manner, the question arises, Why, in the normal state, don't we perceive of ourselves as a pair of separate left and right persons instead of the single, apparently unified mind and self that we all feel we are?

Omni: And the answer required a changed view of consciousness?

Sperry: Not directly. I had earlier proposed that conscious meaning emerges because brain processes adjust to interact with perceived objects rather than copy them. For example, when we look at a house, the brain doesn't so much copy the house as it prepares for a functionally adaptive response with respect to the house: the approach, location, form, memories, associations, and so on.

In wrestling with the split-brain problem, I realized that this kind of interaction with, and response to, objects and other inputs requires that emergent consciousness have a causal impact on brain activity. The normal bilateral consciousness can be viewed as a higher emergent entity that is more than just the sum of its right and left awareness and supersedes this as a directive force in our thoughts and actions.

Omni: So the two hemispheres normally function together as an integrated whole, and the mind as a bilateral unit then arbitrates and integrates the activities within each hemisphere, making decisions that are carried out as physical or chemical events in either or both sides?

Sperry: That's the idea, yes. Putting all this together with some notions about emergence and causation, I found I could see a way around the old behaviorist logic and the mind-brain paradox, a way to finally affirm the causal usefulness of consciousness without violating scientific principles.

Omni: The mind-brain paradox?

Sperry: The puzzling contradiction traditionally posed by subjective versus objective views. On one hand, introspection gives the impression that consciousness is very important in determining our thinking and what we do. On the other hand, objective science tells us that consciousness has absolutely no role in controlling brain activity or human behavior. Each view seems strong in its own right and irreconcilable with the other.

> *"Consciousness, free will, and values: three long-standing thorns in the hide of science. They are in direct conflict with the basic models. Science has had to deny their existence."*

Omni: What about free will, the idea that we seem to have the power to do whatever we choose at any instant, regardless of any laws of brain function?

Sperry: This is opposed, of course, to the old reductionist scientific view that we are causally controlled and have to do everything exactly as we do it—that we could not have behaved other than we did at any time. This was one of the so-called Big Three, another of the great unresolved paradoxes of science.

Omni: What are the Big Three?

Sperry: Consciousness, free will, and values, three long-standing thorns in the hide of science. Materialist science couldn't cope with any of them, even in principle. It's not just that they're difficult. They're in direct conflict with the basic models. Science has had to renounce them—to deny their existence or to say that they're beyond the domain of science.

For most of us, of course, all three are among the most important things in life. When science proceeds to deny their importance, even their existence, or to say that they're beyond its domain, one has to wonder about science.

Omni: Did science deny free will and call it just an illusion?

Sperry: In principle, brain science always assumed it could show just what physical and chemical events in the brain led you to make every single decision you made. Psychiatry and all the behavioral sciences are based on this principle, that all our behaviors, even the slightest mannerisms and nervous twitches, are caused, and if one probes deeply enough into the past, into the subconscious or into brain physiology, one can find the causes and thereby explain and predict behavior.

Omni: Do you think there is any real proof of this determinism?

Sperry: Proof seemed evident in experiments with posthypnotic suggestion in which a person would think he'd done something special of his own free will, but witnesses knew he or she had been instructed to do it under hypnosis and then told to forget having been hypnotized.

Omni: But you believe our actions can be considered free despite this kind of causal control. How can you say this?

Sperry: We have to recognize different degrees of freedom and also different types and levels of causation, including higher kinds of causal control involving mental and vital forces that materialist science has always rejected. Remember that the revised mind-brain model makes conscious mental events causal. It follows that the causal antecedents of any consciously willed act are not just physiological but also mental. It's no longer a matter of the laws governing nerve impulse traffic or inexorable physicochemical mechanisms. We deal instead with a sequence of conscious or subconscious processes that have their own higher laws and dynamics.

The higher order mental processes move their neuronal details in much the way a rolling wheel carries along its molecules or the way different program images on a TV receiver determine the pattern of electron flow on the screen. Only, unlike a TV, not only does the brain "receive" or "play" but it generates, creating its own mental internal programs.

Omni: Are you reversing the usual scientific interpretation, saying neural events don't determine mental events?

Sperry: Not at all. It's always a reciprocal relation with mutual interaction. But because of the long history of reductionist bias in science, we need to actively emphasize the kind of causal control exerted by the higher over the lower.

Omni: So our actions are still caused and directed, but the causes are mental in the

form of percepts insights memories ideas, reasons, and logic?

Sperry. Yes and also feelings, wants, needs wishes, and values We must not forget the right brain Remember also that the mind can quickly scan not only the past but also the projected future consequences of a choice Its dynamics transcend the time and space of brain physiology. When you put it all together on these revised terms, we come out doing what we please, what we decide we want to do And this resolves the paradox

Omni: But actions are still caused, not free?

Sperry: They're free to an extent We're no longer subject to, or in the grip of the laws of physics and chemistry, as inanimate objects are. Nor do we have to obey the laws of physiology, as do our autonomic and reflex responses, our hormones, and our heartbeat. In general we are free of the kind of mechanistic materialist forces with which science used to saddle us We are lifted above these into a higher realm with a different kind of control a control unequaled in freedom anywhere else in the known universe If you think about it you wouldn't really want total freedom from all causation It would be chaos We all want to retain some causal control of our own over what we do We just don't want other things to be controlling us

Omni: I've seen occasional statements that equate your views with animism or dualism, is this a misinterpretation?

Sperry: Yes. I wholly reject anything supernatural, mystical, or occult in favor of the kind of reality validated by science—with the proviso of course that the kind of reality upheld by materialist science for more than a century has to be revised Mentalism is strictly a one world, this world answer I don't see any way for consciousness to emerge or be generated apart from a functioning brain Everything indicates that the human mind and consciousness are inseparable attributes of an evolving self-creating cerebral system

Some people have used the new mentalist concepts to bolster mystical and supernatural beliefs, including those of parapsychology Actually, under the new model mental telepathy, psychokinesis, precognition and the other so called psi phenomena become even less likely than they were before

Omni. In the past it has been a choice the materialist descriptions of natural science on the one hand or various mystical or supernatural schemes of religion and philosophy on the other If the new stance in science rejects both these traditional choices, where does it take us?

Sperry: Well it's just a different middle of the-road alternative, a changed scientific interpretation Among other things, it includes mental and vital forces that science has traditionally renounced Not only does it include mind the historic antithesis of matter but it also puts mind over matter in the hierarchy of causal controls It offers a different right brain picture of reality

Omni. You say these principles are general, that they extend beyond mind brain questions and apply to all the sciences?

Sperry: Yes For example in biology I've illustrated this recently in reference to the old discarded notion of vitalism the idea that life and living systems are characterized by special vital forces over and above those of physics and chemistry

When the early biologists started hunting for these special living or vital properties, they of course failed to find anything The longer, harder and deeper they looked the more convincing it appeared that there were no such things So it was concluded that all living things are nothing but physicochemical processes in different forms and degrees of complexity The idea of vitalism had already become a subject of scorn and derision among nearly all biologists by the Thirties and remains so to this day

Omni: Would you revive vitalism?

Sperry: In a modified form yes, although my colleagues shudder at this because of the mystic connotations of the word A new word would be better but in this case I'm not sure that we should revise the language just because a good word has mistakenly been given bad associations We biologists had merely been searching in the wrong places You don't look for vital forces among atoms and molecules. You look among living things—among cells and animals responding to one another reproducing, breathing, eating running flying swimming building nests, and so on

The special vital forces that distinguish living things from nonliving things are emergent holistic properties, not properties of their physicochemical components Nor can they be fully explained in mechanistic terms This doesn't mean they're in any way supernatural or mystical. Those who conceived of vital forces in supernatural terms were just as wrong as those who denied the existence of such forces In any living or nonliving thing the spacing and timing of the material elements of which it is composed make all the difference in determining what a thing is

Omni: Can you give an illustration?

Sperry: As a very simple example take a population of molecules, say copper You can shape this into a sphere, a pyramid, a long wire, a statue, whatever All these very different things still reduce to the same material elements the same identical population of copper molecules Science has specific laws for the molecules but no such laws for all the differential spacing and timing factors, the nonmaterial pattern or form factors that are crucial in determining what things are and what laws they obey These nonmaterial space-time components tend to be thrown out and lost in the reduction process as science aims toward ever more elementary levels of explanation

Modern molecular biology is quite willing to accept the power of chemical or molecular forces, but when the entities in question are no longer molecules but liv

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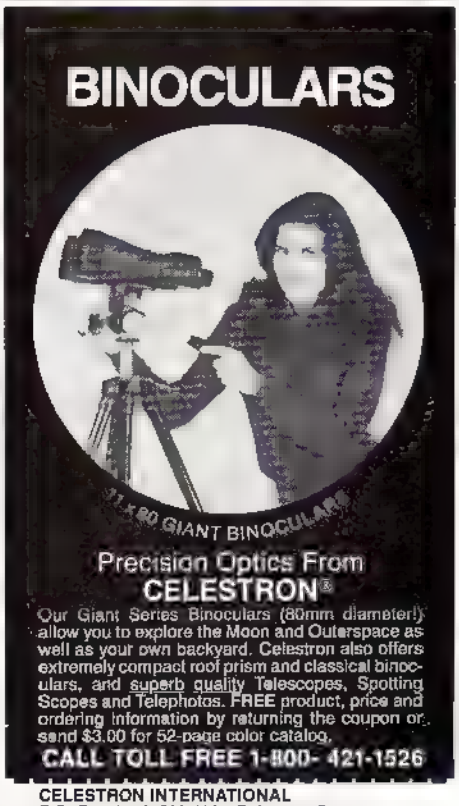

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UNEASY PASSIONS

PAINTINGS BY GOTTFRIED HELNWEIN

Master of the grotesque,
this shock artist has convulsed European society with his portraits of emotional violence

TEXT BY DOUGLAS STEIN

*"I believe in the individual,
not in rules or theories, not in psychologists or scientists.
People find freedom only within themselves."*

Viennese painter Gottfried Helnwein practices the grotesque as an act of self-expression. In 1979 he painted a portrait of a dead child slumped over a plate of food. It was printed in a magazine accompanied by an open letter addressed to an eminent Viennese psychiatrist who says Helnwein, "makes decisions about who is normal and who isn't." The psychiatrist was once an SS leader in charge of drug "experiments" at a children's camp in World War II. As a provocative test, Helnwein himself has walked the city streets with his head bandaged and table forks pulling his mouth into a hideous grimace. Recalling the "mistakes of the past," Helnwein disdains all "big group influences, whether political, artistic, or scientific." His work is a "cry for freedom: The individual must think and feel on his own." Nevertheless, Helnwein is fascinated by two extremes of social organization: the military and the circus. Whereas the military suppresses individual emotions, the circus affirms the passions and dis-

"People always laugh and smile.
It is not real joy, real love—they would much prefer to cry.
TV is the most artificial of all."

torted beauty of "the strange and freaky. Choosing to be grotesque is an act of freedom," he maintains, citing Salvador Dali as a genius of the grotesque Society licks the kneecaps of Dali, he observes, "rather than locking him away in a hospital, as they would most people." Helnwein, who admires Dali's ability to warp social roles, emphasizes that role playing "may be essential for survival." Art and life are inseparable from theater, says this child of the vehemently antiestablishment street theater of the Sixties. Corralling his models from the streets, he distorts faces to conform to his inner visions. "I make my models older or younger, more beautiful, more ugly." His portraits reveal characters convulsed by powerful feelings. The uneasy, spastic potency of their emotions leaves us unsure whether they are laughing or crying, in pain or ecstasy. Whatever the interpretation, one cannot fail to notice that Helnwein delivers a powerful Heimlich maneuver to the solar plexus of our times.∞

WIRED

CONTINUED FROM PAGE 65

"Yeah, well, you know, I'm just a goddamned rock guitarist."

"Yes." He stood up. "Still, it will be necessary to obtain parental permission. Understand he has a mother. His father he doesn't know about."

"I know his mother," I said. "You'll get your permission, doctor." I stood to leave. "You'll get your goddamned permission.

' Above us, the steady drone: kids stamping their feet, clapping their hands.

I'm sitting by Ellerway. "You up to it now?"

He's all fixed up. He actually looks good, really. Plasticene handsome, like the picture on the crystal cube.

'Hurts a little.'

"Yeah, well, we give them just another half an hour, okay? Keep it cool, don't bust a gut. Simple stuff."

"We have to, don't we, Capp?"

"Yes. It looks that way, Ellerway. But let me tell you, we're getting a new manager after this."

Ellerway focuses on me in that funny new way of his, like he's trying to figure me out or something. "Mom says hello to you."

"I imagine she's watching, isn't she?"

"She asked me to ask you if you'd maybe visit her again sometime."

"Sure. Why not? I'd like that, Ellerway. We'll go together."

He opens his mouth to say something, pauses as though changing his mind about what he is going to say, then says, "Are you still ready for whatever comes out, Capp?"

'What are you talking about? I told you you've got to take it easy tonight."

"This might be the last chance."

'For what? The world's at our feet. This is just the beginning.'

I'm sick inside. My anger at Spud, my fury and indignation at Hardesty are making me crazy. The worry for Ellerway nudges it all into a whirlpool of queasy anxiety. But I won't let her get me. Ellerway's got to get up on the stage again.

He gets up, shrugging away my offer of help. 'Okay. Let's go out and play.'

We trudge up the ramp, take our places and begin to bash away into "Dance of the Degenerates," our most upbeat number.

I signal for Benny to play on a percussion solo. Might as well save Ellerway, give him a break for the next song, which was going to be a little tougher.

I drink a Coke. It does nothing to settle my stomach.

Benny builds up the volume and rhythm to an almost unbearable crescendo. Time to move. I tap out the program of the next number, "Protodeath," on the keyboard at the base of my Gibson and get ready for the climax.

Benny tosses drumsticks again, one to either side of the stage.

Then he hits the keys on the machines and the sounds instantly stop. No resonance, no echoes; nothing.

The silence is deafening. It catches the audience by surprise. The lights dim to black except for those drumsticks, which glow. With a slow implosion of sound from Benny's machines, like a giant sucking in breath, the drumsticks begin to grow into amorphous blobs with soft red light glowing from within. Slowly the shapes take form. Kid the Flash. Jim Capp.

I touch the tooth communicator, with which I can speak to Ellerway above the racket around us.

"Ready, chum?"

And he says, "God." With a sigh, "I never thought it would be like this."

I cut in my chords. My holograph mimics the real movements of my hand.

The holograph of Kid the Flash leans over and picks up a chord and a microphone. A sharp microphone. He jams it into his abdomen. It emerges from his back.

To the rhythm of the music, a slow pulsing dirge, he weaves around the stage,

Ellerway looks up. He walks slowly over to me as the applause swells. I can see the tiny, fresh stitches in his neck. Two drops of blood well up on the line of his throat.

shedding gobs of light, blood all over the stage. A great tide of the blood flows over the side of the stage, whirlpools into a dense red mist, obscuring everything but random light from within.

I stand beside my holograph, continuing the dirge, letting the synthesizer play with it so that it sounds like the song of some mammoth pipe organ.

The mist gradually fades.

The real Kid stands inside an elaborate coffin, hands folded ceremonially, eyes closed, in funeral tux and tails from the Victorian Age.

His eyes open. His hand reaches to the side of the coffin, takes a wire, and plugs it into the jack just under his ear.

The crowd's roar nearly drowns out the music. His arm slowly snakes out, a finger points at the audience. Stiff-legged he walks out, mouth open almost as wide as Marley's, and screams an all-keys played-on-the-organ yell. Hologram-mist white as frost, streams from his mouth.

It continues as he sings the song, his understated delivery caused by his weakness making the song all the more chilling. 'Protodeath, protodeath, we're trying on the grave for size.

Worms are here already, coming through your ears, your eyes.

A large television set rises from the misty floor, holding a picture of the band. Holograve-stones rise from the pond of fog that bathes our feet.

Then the Kid takes one of my spare guitars in his hands. This isn't in the act. I crash out the last chord, which warbles and slowly decays into silence.

And then Ellerway cries, "Shit on this!" with all the power of the scream that began the song. He bashes my Stratocaster into the TV screen. With a smash of sparks the shattered glass is sucked into the tube, then falls out at his feet. Smoke gusts up. The power cables inside the huge set flail and snap with flashing intensity. Holding my ruined guitar in one hand, Ellerway cries, "But we're not dead! We're alive!"

His subvocalized voice comes over to me on my receiver, shaking my eardrums through bone conduction.

'It's now, Capp. It's got to be now.

"What are you talking about?

"Benny, Jim. We're doing 'Dreamfight' next."

I hear Benny say 'Hey, pal, that ain't on the playlist.'

'I can feel them, just out of my reach. I want to touch them, not numb them. You with me, Capp?"

"Fuck Ellerway. We could get in all kinds of trouble."

I see him across the stage, staring at me hard and demanding. His expression so intense, I have to turn away.

I look up past the darkness of the blank blackened faces of the crowd wriggling on their wires. Past the light-canopied 3-D camera setups, up to the opaque bullet-proof glass pane of the sky suite. I think of the power I've got now, the power and the adulation, think of the money.

And then I think, *that bitch up there has had it all for years. What does she want now? More. She wants all of me. She has a part now. But that's all she's ever going to get. And as long as I'm alive, she isn't going to touch Ellerway.*

Okay, Tom," I say. 'It's your show.

I smile up at the sky suite and give the old lady the bird.

Ellerway smiles at me wearily. "Improvise around me. Right. And one and two and three."

He brings down his hand. I strike mine across the strings, trying to remember the song. We've practiced it maybe two or three times, it was a scribbled on paper. Neither Benny nor I can remember much. I hit the chord again, then start phasing it with the manual on the computer board. I've got the hall's acoustics down now, and I can play with them. I sneak the sound around, whooshing like a broken helicopter about to chop off the crowd's heads.

Ellerway signals Benny to come in. The drums begin to crank along recklessly, restlessly. I slam out another chord and diddle with my memory of the basic me-

ody of 'Dreamflight.'

With a the money rid ng on this g g the d rector and technic ans aren't about to turn off the power just because we change songs in the m ddle of a set. So they just put up a shifting webwork of spots and filters, no doubt computer-contro led to change with the shadings of the music and they let us be.

El erway starts w th the standard polyphonic attack, a f ve-scaled cho r of hundreds of vo ces branch ng out from his own weav ng delicately among themse ves their intr cate network of rock fort s-simo and rock dissonance. The harmon c fabric vau ts you into some etherea emo-t onal plane wh e the cacophonic aspects make you rea ize that you are really dan-g ng from the cliff over death s blackness. Somehow El erway manages to reca the bass ne of 'Protodeath' bu ding an entire y new chorale above it.

The night dawns upon us all
Chinchi a ch ll
Sharp c aws, sharp jaws
Tear ng at your heart. Dead fal.

The fluid vo ces sudden y congea nto one vo ce. E erway s rock-be ow of rage. My guitar computer geared to sense the change switches t mbre n midnote of my me ody lacing. Automat ca y, it growls a sympathet c chord, a most as f E erway were control ng it.

The song is inside me and abrupt y t becomes the focal point of my ex stence. Just a po nt, mind you. Something smal and concentrated; I could feel t feed ng nto me from the power of the guitar, from the a r wh ch buzzed with it.

God knows what is going through the actual wires to the l steners.

El erway sings. The stuff nside h m—the frequency modu ators, the augmenters, the microtransistors, the m nicompu ters, al flesh-enmeshed mach nery—takes his wishes and makes them music. Perfect sh mmer ng control.

As my hands grab and flutter and dive bomb the str ngs, paus ng only occas on a y to fidget with the computer controls, I suddenly rea ze what he is trying to do.

I want to stop, to tackle him or some thing, but t s too ate. I'm into it. The music has me by the short hairs. E erway's voice s pu ng my strings.

play ke a demon. A demon caught n a shaft of l ght from heaven and reluctantly r sing up into the sky among the chora ng host k cking and screeching and yow ng al the wh e.

And damned if I don't remember the whole song just as we had practiced it.

I can fee Benny s thump ng beh nd me, b ow at my sweaty hair. know he is synchronized with El erway as well.

It flows out, beaut fu and nasty and r ght. Gut stuff, with all of E erway's fee ngs and thoughts somehow m xed in for good measure. I can fee E erway nside me. I recognize part of him from the two years of our work together, but there is so much more. My juices move with his. They dance

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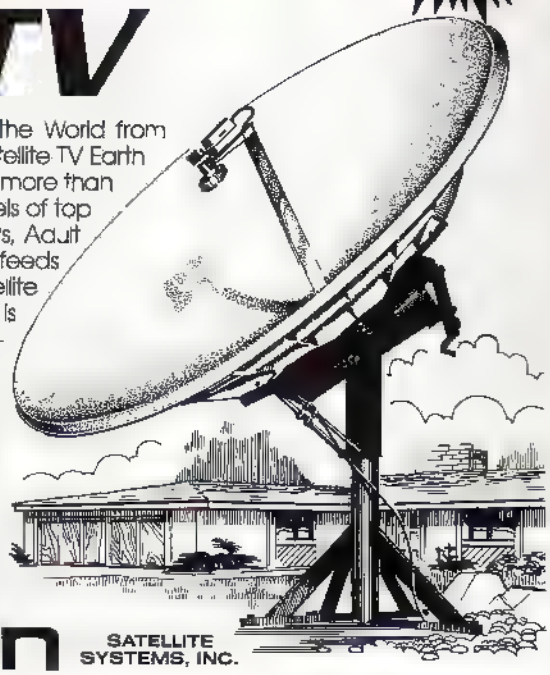

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The song mixes my feelings with Ellerway's by some kind of special electric chemistry that I don't understand.

My guitar trills in sympathetic stridency like the *Hallelujahs* and *Praise the Lords* rhythmically filling in the beats and music of a preacher's chant at a revival meeting.

'I'm like you just like you,' Ellerway sings. Suddenly a whisper-choir rises all around, repeating the phrase in various complementary musical permutations molded to Ellerway's subtle changes, his nuances of emotion. It's not just his performance up here, an act, a piece of plastic slapped with paint and pretty costumes sitting amidst a castle of equipment.

It's Ellerway stripped of pretense flowing honestly, simultaneously showing his own person and embodying a common denominator of humanity. My guitar lines and Benny's drums fill in as best they can, but they're essentially drowned in the heat and light of Ellerway's song.

He takes off his Victorian topcoat and his shirt, leaving his chest bare. He plays on the chest keyboard, flips this switch that dials upon his arm. Sweat runs down the crevasses of his scars, mixing with the blood that's leaking again.

The stainless steel, grotesquely protruding from flesh like metal bone, shines in the rainbow light. Wires snake under his armpits, stitched through his abdomen like plastic leeches. His hair hangs limp down his back where bolts glint.

He's still got the jack plugged into his neck, but I think he's getting weak. He sways a bit, then spins around and signals Benny and me to stop.

We do.

Slowly, breathing hard, he turns again and points to the audience.

"Music, our senses' essence.
Distillation of metal and will.
Missionary moonshine.
Come drink from our steaming still."

He gestures wide, bows his head.

A ghost shiver dances down my spine, deep into my bowels.

Something inside me goes out to him. I can sense that the audience is having the same experience. My guitar still sings. I look out at that lake of faces. It is calm, quiet.

No thrash of limbs. No flail of wires.

They stare at Kid the Flash.

Ellerway opens his eyes wide, wider, seeing something beyond those faces.

He touches them. He feels their song. The songs of their insides. The harmonics of their souls.

He knows them all. I can see it in his expression. I can feel it moving inside me. Recognizing me.

Recognizing me and all that I am.

He gasps. He tries to sing the song he feels, coming from all of us, telepathic thought-rock crashing in on him. Fifty thousand mind-hands reach for the mike he holds to scream their life, wail their despair and joy to others.

He sings one note. No word. Just song. It's piercingly beautiful. Another. Another. A melody is formed. Slowly he synthesizes the instruments for the song. The electronic background. The song is his as much as anyone else's.

The song sings of bodies riddled with metal. Bodies hanging crucified on the skeleton of a dead electronic culture. It cries and weeps and despairs.

It hints of lost possibilities.

When it comes, I hear the *snap* distinctly. A blue-white spark jumps from a length of wiring in his chest. Another arcs from his neck. Blood spills from his mouth. Smoky flames lick up his chest.

He falls.

I dash to him. I yank the plug from his neck. My guitar flops against my thigh. I tear it off, I rip my shirt off to smother the flames. I can smell charred flesh.

This was never supposed to happen. Too many safety precautions.

Benny's there too, all of a sudden, with wet towels. Steam rises up desperately.

The medmechs finally arrive.

"The holograph of Kid the Flash leans over and picks up a chord and a microphone. The real Kid stands inside a coffin, eyes closed, in funeral tux and tails."

Almost the moment they do, the jerks at the lighting switches finally get the smarts to drop the light curtain. It shimmers on, cutting off the vision of thousands of stunned faces.

The roadies run for a stretcher.

Ellerway is still conscious. His eyes are glassy. Faraway.

'I . . . I . . . did it. For a moment I felt . . ."

'I know, Ellerway," I say. 'Now rest. You've done some heavy damage." I'm numb inside. The guilt sits like lead in my stomach.

He turns to face me as a medman squirts some foam over the glowing metal, the melted plastic. Capp."

'Shut up, I said."

"Capp, I could touch you, too. I know now, Capp. I know about you. And it's okay."

I turn to face inside. 'What?"

His eyes close.

"What's wrong?' I ask the nearest doctor. "He's not —'

"No. Not yet.

They cart him off. The burning smell is still in my nostrils. I start to follow. Benny stops me.

"Nothing you can do, Capp."

' Shit, I've got to do something." Tears of rage and frustration leak from my eyes.

He looks at me with a penetrating stare that says "Yeah, and I know too.' He picks up my guitar and hands it to me. "Keep on rockin', kiddo."

He walks away, shaking his head.

I can hear the voices of the crowd crying out from beyond the light curtain. "Kid. Kid. Kid the Flash!" I can hear seats being ripped out, cups crashing, wires whipping. I hear robo-security pushing them back as they try to leap through the light curtain.

The robots click and hum with mechanical strain.

I take my Gibson, my thirty-year-old hundred-thousand-dollar, souped up Gibson and I smash it into an amplifier.

All that was two years ago.

Now . . . Now I've got my million-and-a-half-buck house in the canyon. I've got another house on the East Coast. I hung onto my cabin, too. I've got money in the bank, money invested, money coming out of my ass. I've got a state-of-the-art recording studio in the basement, stocked with any musical instrument you'd care to name.

I've got a Jacuzzi. I've got a sauna. I've got a cook and a housekeeper. I even picked up a contract wife.

Kid the Flash is no more, but the crystals keep selling. The concert where he did his trick is the most popular vid-disc in history.

And Ellerway is still around, despite the rumors to the contrary. They had to rebuild him, of course. They had to pry the twisted mass of fused plastic and metal from him, treat the burns, graft back flesh and bits of organs. He can talk. He can't sing yet. They're working on that.

Hardesty got her pound of flesh. She's happy. She even suggested that I form a new band, which she would back. I told her to shove the idea. I'm retired. I return any mail or messages from her unopened.

Benny's in a new band. Managed by the Spud. Owned body and soul by Hardesty.

Ellerway comes around once in a while. He's still a little wary of me. I can't blame him. We talk and play together.

He mostly writes music now. He's working with a group of scientists studying the processes he introduced. I hear he's even thinking about bringing out an experimental album next year. He looks a little different. He's a lot quieter. When conversation has dried up and we're sitting on the patio, he gets this glassy stare as he looks down into the misty valley.

We never talk about Kid the Flash or that final concert.

We never talk about his mother, though we both see her from time to time and her coolness and her contempt toward me seems to be fading.

But I've promised myself. From that moment at the end of the concert, I've promised myself that I would explain to him. I don't know if he'll really understand, but I have to try to make him.

One day it will all come out and we'll really know each other. One day. ∞

EVOLUTION'S CHILD

In a million years, the world will become the dominion of a superrace of children.

BY PAMELA WEINTRAUB

They have been scouring the desert for weeks when they discover the sky. The elements have pounded the jawbone to pale white shards, but much of the dome remains intact. They return back to their desert lab to glue it together, and when they finish they are stunned by the immensity of their

PAINTING BY DI MACCIO

The parched and crumbling desert lies on the eastern edge of a landmass once called North America. The earlier inhabitants, the researchers believe were erect-walking creatures some six feet tall. Examining the skull, they calculate that these ancient men had brains half the size of theirs, with twice the jaw and 36 teeth to their own 28. This skull the hefty explorers conclude with rapture, belonged to their puny ancestor *Homo sapiens*, by now a million years gone.

The explorers in this scenario, with bald bulging heads and slitlike mouths, fit our twentieth-century notion of aliens from space. But if some of today's anthropologists and paleontologists are correct, they will be mankind's descendants a million years hence. They will live twice as long as we do, and their years of extra development will provide them with a greatly expanded cortex and the intellect to match. Their spectacular ascent will be achieved through *neoteny*, the same process that helped us evolve from the apes.

Neoteny is the biological mechanism that allows some species to retain infantile or neonatal traits throughout adult life. The idea that it might be a controlling force in *human* evolution was first suggested in the Twenties by Dutch anatomist Louis Bolk. Bolk observed that both adult humans and baby apes have small jaws, relatively large brains—about one fiftieth the weight of the body—and the ability to walk erect. Grown-up apes, on the other hand, have large jaws, relatively small brains—about one hundredth the weight of the body—and a four-legged gait. Bolk theorized that apes and the ancestors of humans had originally developed in similar ways, but in the course of evolution, the pace of human development simply slowed. The result: Men and women were perpetual neonates, never reaching the small-headed, four-legged 'maturity' of apes.

As far as Bolk was concerned, neoteny had provided humankind with extraordinary evolutionary strength. By endowing successive generations with the most powerful juvenile feature—a brain that is large in comparison to the body—the neoteny mechanism had slowly turned our sedentary apelike ancestor into the most mobile, innovative and successful creature on Earth. The large-brained juvenile, Bolk declared, had dominion over all.

Bolk's theory received widespread support during the Sixties and Seventies, when paleontologists began excavating bones in the sweltering African plains where humanity evolved. Their discoveries showed that with each step in human evolution the latest species always had larger heads—making it, in effect, more childlike"—than the species that came before. The cranium, the researchers asserted, had started to expand millions of years ago, when our apelike ancestors moved out onto the open savanna. Without the protection of trees, their survival, *depended* on increasingly complex brains to design tools as well as an upright stance that left the hands free for toting objects.

Still, until recently, scientists dismissed the idea that neoteny would be a major force in *future* evolution. In fact, most believed that in the centuries to come, any kind of human evolution would be insignificant. Some researchers acknowledged that nature was still refining the knee joint or increasing resistance to disease; others admitted that genetic engineering might one day allow future man to eradicate cancer, improve eyesight, and sharpen hearing. But for the most part, experts argued human evolution had ceased. A species, they explained, evolves only when pressured to change by its environment. And as civilization eased the rigors of survival, evolutionary pressure on the human animal had come to a halt.

In the past few years, however, researchers such as New York University paleontologist Noel Boaz have rebelled against that point of view. Tall and rugged

> *Boaz believes that a million years from now, the human head will be as much as one fifth the length of the body—the same ratio as that of six-year-olds today.*

looking more than a little like Indiana Jones in *Raiders of the Lost Ark*, Boaz started seeking the origins of man during his Berkeley grad school days in the early Seventies. In 1974 and again in 1981 he explored the heart of Africa in search of bones that would shed light on man's beginnings. This year he has left for Lake Amin Zaire to search for the missing link—the common ancestor to both man and the apes. His excursions into the past, he says, have convinced him that "people will continue to evolve just as they always have—according to trends already in place.

"Two million years ago," Boaz explains, "our ancestors had a cranial [brain] capacity of eight hundred cubic centimeters. A million years ago they were up to twelve hundred fifty cubic centimeters; today, perhaps fifteen hundred cubic centimeters. If you extrapolate the line on a graph, you'll see the brain growing to about twenty-five hundred cubic centimeters a million years from now. There's no reason why that line should taper off."

Boaz's prediction stems from his belief that, contrary to prevailing opinion, environmental pressures have become more stringent than ever. "The new driving force in evolution," Boaz contends, "is the increase in the complexity of life. Hunters and gatherers had to find food and shelter, and that was hard. But today the problems are multiplied. Everyone has enormous options, and those who can't negotiate the diversity succumb to breakdown, schizophrenia, depression, suicide. It's obvious that these people aren't as likely to reproduce. To avoid such calamitous outcomes, we have to have a certain kind of smarts—the kind that may well come with increasingly larger, more neotenic brains."

Today the adult human head is one eighth the length of the body, but Boaz believes that, thanks to neoteny, a million years from now it will be as much as one fifth the length of the body—the same head-to-body ratio as that of contemporary six-year-olds. The human jaw, he adds, would have more or less receded under the face, because with such a large head, something has to give." Boaz acknowledges that it would be difficult to move or support such a head, but explains that all we need do is develop muscles and ligaments around the neck. Since the brain consumes about 25 percent of the body's metabolic energy, a larger brain could require a larger body to provide it with food. That might well be accomplished by increasing overall body height to perhaps seven feet. Some people, he adds, say bigger-headed babies would crush the mother's pelvis, but the answer to that would be premature birth. Presumably neonatal medicine would protect future babies born before term.

Boaz's beliefs are speculation, based largely on fieldwork and discussions with his students. But according to his colleagues, a considerable body of research supports his ideas.

Some of that research comes from Dale Russell, a paleontologist at the Canadian National Museum of Natural Sciences, in Ottawa. Russell is best known for his model of the dinosauroid—a large-brained, humanoid reptile that might have evolved by now if the dinosaurs had not become extinct (see "Smart Dinosaurs," April 1982). When Russell unveiled his full-scale, four-foot five inch dinosauroid in 1981, it thrust him into the international limelight. It also suggested an intriguing possibility: If the size of the dinosaur's brain could increase so drastically over time, wouldn't the same be possible for other species, including modern man?

Russell felt sure the answer was yes, and he set out to substantiate the idea by studying the increase in biological complexity over the millennia. Referring to the fossil record, he found that the size of animals and plants, the total number of species on Earth *and* the size of brains had increased through the course of evolution.

"Some dinosaurs had pretty big brains when mammalian brains were still small," Russell explains. "Yet when the dinosaurs were eliminated, average brain size didn't go down. Instead, the mammals took over

CONTINUED ON PAGE 102

"Meier met Jesus Christ and shot an out-of-focus photo of the eye of God"

ANTI-MATTER

UFO UPDATE

Rouged and radiant blue-eyed, voluptuous, and blond she could leap out from the pages of *Vogue* She's as torrid a number now as she was a century ago. Her name is Semjase and if you believe a Swiss farmer named Eduard "Billy" Meier, she is a three-hundred-year-old emissary from the Pleiades star cluster

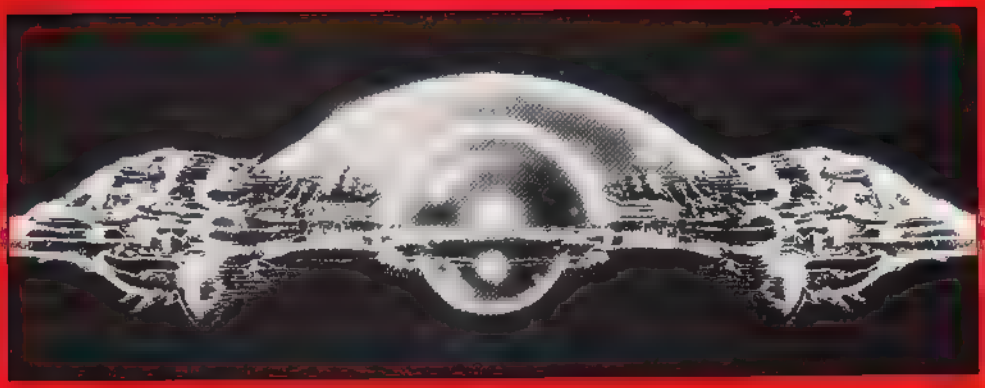
Semjase and four other Pleiadean cosmonauts, says Meier, have been visiting him in their flying saucers since 1975; they've even taken him for jaunts into the past and through the universe Semjase once introduced him to Jesus Christ, who made Meier his fourteenth disciple On another occasion, Meier shot an out-of-focus photo of the eye of God And in July of 1975, he snapped a close-up of the *Apollo* and *Soyuz* capsules linking up in orbit

Meier has taken so many pictures, in fact that a group called Genesis III Productions, headed by retired U.S. Air Force Lieutenant Colonel Wendelle C. Stevens, has compiled two books of them Most of the shots show saucers soaring above trees and meadows, with the Swiss hills undulating in the distance. According to Stevens, Genesis III had the photos analyzed by NASA scientists, who could find no traces whatsoever of a hoax; unfortunately, Stevens adds, "the researchers asked not to be identified

UFO experts, however, claim the photos are bogus. Jim Lorenzen, of the Aerial Phenomena Research Organization, says he can prove the saucers in the photo are 18-inch models. Bill Spaulding, of Ground Saucer Watch analyzed the photos by computer finding double exposures (saucers superimposed on meadows) in some, and string holding up the saucers in others Kal Korff, author of *The Meier Incident: Most Intentious Hoax in Ufology*, says witnesses have discovered flying-saucer models on Meier's [illegible] as well as film negatives of models lying half-burned in Meier's garbage can. "The eye-of-God photo adds Korff, "was clearly a blurred shot of the Ring Nebula in the constellation Lyra. And the Apollo-Soyuz photograph was obviously taken directly off a television screen: it didn't even show the actual space capsules, just simulations that had been given to the networks by NASA.'

None of this, however, has stopped people from believing Meier. He's sold photos and articles throughout Europe and the United States, and a full blown cult has formed around him. The believers, who call themselves The Semjase Silver Star Center, live with Meier on a communal farm, providing him with funds and shelter. "When I met him,' says Stevens, "he and his family were living on a dirt floor in a chicken coop Now he has a nice apartment, a TV, and an IBM Selectric typewriter '

Some people hint that Meier has enjoyed other benefits During those intergalactic voyages, they say, he and the stunning Semjase became romantically involved. "That s ridiculous," scoffs Stevens. "Pleiadeans really don't like humans we carry too much lust and greed in our aura Semjase told Meier that making love to him would be like rolling around with pigs "—*MARK TEICH*



AUSTRALIAN UFO

Last year newspapers throughout Australia carried the story of one Noel Martin, who claimed that a flaming UFO had plunged into the bay near his New South Wales home some 25 years before. The haunting image refused to fade, Martin told reporters; so at age thirty-two he quit his steel-mill job to start UFO Discovery '82, a company dedicated to finding the sunken craft.

Martin's flamboyant quest quickly caught the eye of Jonathan Daemion, a self professed "psychiatrist of the supernatural," and before long Daemion had written for information. Martin responded with a list of 300 bay-area witnesses convincing Daemion that finding the vessel could mean millions in movie book, and toy contracts. After speaking with Martin Daemion accepted the job of public-relations officer in the new company and happily set about raising $600,000 for the project. But when Martin refused a $100,000 donation from a television station willing to film the recovery, Daemion smelled a hoax.

Although he'd never seen the actual crash site, Daemion now left for the New South Wales bay in his mobile home. After two days of interviewing people cited in the initial witness list, he concluded that "Martin had fabricated almost everything."

Martin's older sister, Margaret, for instance, said that she recalled some strange lights but no crash. And his younger sister Helen, had no memory of the incident at all. "My brother believes I was with him when he saw the crash," Helen recently told *Omni*. "But I don't remember it. I was only five at the time. Anyway, I'm too busy with my kids to be bothered with this nonsense."

When contacted for comment, Martin himself insisted the UFO was real. "In fact," he said, "I just found it. It's an underwater bulge covered with seaweed and everything. So I'm not crazy. But my engineers tell me we can't raise it until we raise five hundred sixty thousand dollars for huge cages and cranes. Okay?"

In Daemion's professional opinion, however, such claims prove that Martin has begun to lose touch with reality. "The water in the bay is only twenty-five feet deep," he explains. "If Martin wanted, he could probably raise his 'bulge' with a tendollar inner tube. But I won't be the one to tell him. The guy's unemployed. What else can he do?"

—Peter Rondinone

"I have a friend who told me that the very best computer system ever built by mankind was by the Druids at Stonehenge. Well, that's an old story. But what I liked was that he felt the Druids didn't die out, they just went bankrupt trying to debug the software."

—James Finke

"If you brainwash people into forgetting that they're part of each other, you can manipulate them, and that's how individualism leads to fascism—divide and conquer!"

—Dr. Slater

MERPEOPLE OF NEW GUINEA

The Nakela clan of New Guinea was performing a ritual mourning dance when the drummer made a mistake. Members of the troupe were so humiliated they jumped off a high sea cliff. Their bodies turned to rocks that can still be seen, and their souls became mermaids and mermen, or *ri*.

This ancient tale is only a myth. But if anthropologist Roy Wagner, of the University of Virginia, is correct part of the haunting legend may actually be true. Wagner claims that dozens of New Guinea natives may have *seen* the merpeople—creatures with human heads and torsos and legless lower trunks terminating in fins.

Wagner first heard of the *ri* in 1979, when an elderly New Guinea man mentioned the terror of a merperson cast upon a beach decades before. Intrigued, the anthropologist went on to "interview everyone who claimed to have encounters with the creature." One man reported a teen-age girl *ri* caught in a net by a native fisherman. A ten-year-old boy described a line of male and female *ri* swimming into a freshwater stream by moonlight. And others mentioned that fishermen sometimes butcher *ri*, then sell the tasty flesh on the open market.

Eyewitness descriptions of *ri* vary considerably, Wagner reports, though most concur on the basic

points: The upper torso of the creature is human or humanlike, with long, dark head hair and relatively light skin. The females have obvious mammalian breasts and each sex has humanlike genitals on the front of the lower torso. Fingernails are long and sharp, the palms are ridged and callused, and there is something strange about the mouth. They breathe air they live off fish, and they aren't known to speak.

When questioned about the report, biologist Roy Mackal, of the University of Chicago, said, 'A real mermaid—half-fish and half-human—is genetically impossible. But the creatures could be an unknown sirenian, the group of mammalian species that includes dugongs and manatees. It's even possible though highly improbable that *ri* are a genetically defective, inbred group of humans. Because of the anecdotal nature of the evidence, though, it's really difficult to hazard a guess.

Wagner himself concedes that "from an anatomical and evolutionary perspective, the *ri* does pose problems. But," he insists, "the credibility of some of my informants can't be lightly dismissed." He and Arizona cryptozoologist J. Richard Greenwell plan to visit New Guinea sometime soon in search of 'the creature unknown to science.

—Marcello Truzzi

"Now I will believe that there are unicorns."
—William Shakespeare

"I am a brother to dragons."
—Job

BANK-ROBBERY DIET

In June 1981, Ronald Springston, thirty, walked into a small bank near his home in rural Wheeler, Arkansas, drew a pistol, and politely instructed the bank teller to pile money in a blue nylon bag. Springston drove off with the bank janitor's car and $8,000 in stolen cash.

Arrested several days later, he claimed that the holdup pistol had been empty and that, incredible as it sounds, hypnotic weight-loss therapy administered two weeks before the crime was responsible for his conduct. It seems Springston was 50 pounds overweight and had tried hypnotism to break his eating habit. The hypnotist put Springston under, then allegedly told him he had the self-confidence to diet, or even to rob a bank. Springston began to shed pounds but pulled the bank heist, too.

Springston's attorney, W. B. Putman, argued that the rob-a-bank bit was part of the hypnotist's "regular patter." Springston couldn't get the hypnotic suggestion "out of his mind. It kept building and building, and obsession became compulsion." Springston, Putman said, was also an epileptic, and that made him exceptionally susceptible to hypnotic suggestion.

Despite the clever defense, jurors failed to reach a verdict. Rather than face a new trial, Springston bargained for a lenient sentence, serving four months and ten days as a model prisoner at a federal correctional facility. He was recently released.

Springston found prison conducive to dieting, and he notes, "I lost fifty-one pounds while there."

—Eric Mishara

EATING AIR

He eats air, sleeps a few hours a week, and lifts ten times his weight. Who is this wonder man? If you believe a recent advertisement, he's Wiley Brooks founder of the Breatharian Institute of America, based in mellow Marin County California

Brooks (at right) author of the book *Breathe and Live Forever*, says he derives all his nourishment from air and cosmic rays. The breatharian philosophy, he adds, is a throwback to ancient times, "when man condensed air into solid and liquid nutrients." Ordinary food deposits poison in the body, he explains and the result is death

To spread the word Brooks currently gives one-day seminars (cost: $100) in which students are taught to make the transition from carnivorism to vegetarianism fruitarianism, liquidarianism, and finally, breatharianism No restrooms are provided for advanced students, Brooks notes, since, "if nothing's going in nothing's coming out."

Though Brooks admits to occasionally imbibing orange juice, he emphasizes, "It's only to cleanse the system of all the pollutants one encounters when living near a city." Some of his former associates however, claim that breatharianism is a sham and that Brooks is in fact a secret "sugar addict and junk-food junkie." He has reportedly been caught eating a chicken pot pie and was

seen leaving a food store with a bag full of groceries Brooks himself denies these accusations, claiming they were perpetrated by his jealous ex-girlfriend

Since it's alleged that none of the institute's disciples have ever stopped eating however, Brooks may be the only "true breatharian in the world

—Robert Sheaffer

"Gravity is a trick of the body devised to conceal deficiencies of the mind."
—La Rochefoucauld

REVENGE OF THE NEEDLEFISH

Dr. Peter Barss had been at the Milne Bay Hospital in Papua, New Guinea for just a week when some villagers found the body of a dead fisherman. The young doctor's autopsy revealed a sharp piece of bone (the tip of a crude knife, perhaps?) lodged in the man's chest A week later villagers found another dead fisherman, and this time Barss discovered the culprit a thin, silvery fish, alive and kicking deep inside the man's stomach

After several similar incidents, Barss finally realized that the fishermen were being massacred by foot-long predators called needlefish The streamlined fish leap from the water at great speed, Barss claims and literally stab the fishermen with three-inch-long bony snouts

Though most people think the shark is the most dangerous fish in the ocean," says Barss "it kills only about ten people a year worldwide. The needlefish however takes more than twenty lives a month. In one week he adds, four fishermen died of stab wounds to the chest or stomach, three were blinded in one eye, and two were knocked unconscious

Since most people have been attacked at night while using lanterns, some doctors suspect the fish leap for the light like moths striking their victims accidentally But Barss says this explanation may be inadequate. It does not, for instance, account for the three-year-old girl who was paralyzed after an attack in broad daylight. The villagers, in fact, believe the fish have begun a holy war. Tired of being yanked from their homes, they've decided to even the score The locals Barss reports have even begun chanting incantations, calling upon the magical "forces of righteousness" to save them from the briny thugs

Barss, however, hopes the attacks don't get too much publicity. That, he says, might cause fishermen everywhere to outman and outgun the fish to the point of extinction. "That would be a shame," says Barss, "because needlefish are still very nice to eat

-Peter Rondinone

The skeptic does not mean he who doubts, but he who investigates or researches, as opposed to he who asserts and thinks that he has found
—Miguel de Unamuno

X RAY

CONTINUED FROM PAGE 54

country has lots of coal but coal contains lots of pollutants he says. "These metal contaminants like vanadium, which corrodes turbine blades, are so tiny that conventional tools can't tell you how they're bound in. If we knew that, we could develop ways to get rid of the contaminants.

Geologists are using the X rays to study conditions at the earth's core, where the heat and pressure are tremendous. Scientists simulate core conditions by squeezing minerals mercilessly between two diamonds. CHESS's X rays show how the minerals' atoms stand up under this kind of punishment.

Other researchers are using CHESS as a kind of strobe light. Because the circling particle bunches shoot X rays into the CHESS booths only when they whip by the window in the storage ring, the radiation arrives in pulses. That gives scientists a chance to film the jostling, shuffling, shoving, and scrimmaging on the molecular level. This is high-speed shooting beyond a sports photographer's wildest dreams. CHESS's X ray bursts sizzle into the booths every 2.5 microseconds, and each burst lasts for a mere 150 picoseconds, or 150 trillionths of a second. "You can use the beam to take snapshots that show how a structure is behaving now then a billionth of a second later," says Dennis Mills, one of the CHESS staff scientists.

Dennis Mills is only thirty. "Five years in this business makes you one of the grand old men," he says—but he has already used the CHESS strobe effect to raise a rumpus in the semiconductor industry. During manufacture, a silicon chip's skin can become smudged with ions. Manufacturers use powerful lasers to scrub the chips clean, but they have never been sure how the process works. Does the laser melt the crystal? Or does it move contaminants around by snipping the electron bonds holding the surface atoms together? "Guys would get up at conferences and really argue about this," says Mills. "The fights just raged."

Using CHESS's pulsing X rays, he photographed a laser's effects on a crystal at intervals of 100 billionths of a second. The photos showed that the surface had melted. "If you understand the mechanism, you can improve the process," he says.

But the experiment raised new questions, revealing that the melted crystal grows back thousands of times faster than anyone predicted. "I don't think the story's completely told," Mills concludes.

Physicists are not synchrotron radiation's only fans. As Mills puts it, "Biologists are ecstatic over this thing." One enthusiast is Keith Moffat, a Scottish biochemist based at Cornell. He uses CHESS to study big protein molecules, including hemoglobin and polypeptide hormones. They have important roles in the body, but they are so complex they remain poorly understood. "They may be made up of several hundred different amino acids," says Moffat. To study the atomic structure of these compounds, he must grow them as crystals, an extremely difficult task. Creating a crystal large enough for ordinary X ray study about the size of a period at the end of this sentence, can take months. CHESS's X rays are so potent, however, that Moffat can use crystals only one fifth the usual size. "The synchrotron makes some things that were difficult easy and some things that were impossible possible," he says.

Moffat's goal is to understand breathing at the molecular level. He is using the X rays to learn how hemoglobin's molecular anatomy binds in oxygen. It is a lone iron atom in the molecule that does the work.

Under a grant from the National Institutes of Health, Moffat also is studying a hormone similar to human growth hormone. This hormone is used to treat dwarfism and may help heal burns and bone

> *"Synchrotron X rays could be used to produce a three-dimensional view of the whole body. Surgeons could examine a beating heart by walking around its holographic image."*

fractures. It is scarce, however, available only from cadavers. "Genetic engineers are hot to make it themselves," says Moffat. Studies of its molecular structure may eventually lead to hormone factories. So tiny are its crystals that, without CHESS, he would not be able to study it at all.

In another Cornell laboratory, biochemist Martin Caffrey works with CHESS home movies of cell membranes. With his Dublin accent and shoulder-length hair, Caffrey looks more like a rock guitarist than a man fascinated by the minute cell-to-cell transactions that collectively make us what we are. But he is absorbed in such questions as the precise way in which neurotransmitters travel from our nerve cells to our muscle cells, enabling us to play Chopin or eat spaghetti. Caffrey examines structures too small for even an electron microscope by probing cells with CHESS's X rays and studying the resulting photographs for diffraction patterns.

Late one night Caffrey is in his Cornell laboratory, delicately fingering the joystick of the computer he uses to study these patterns. As he positions a data-generated image of a nerve cell membrane on the screen, something like a blue lifesaver materializes, blurs, grows, then shrinks back to a blue lifesaver. "What we're actually seeing there is the loss of six molecules of water," says Caffrey. "This type of thing has never been done before."

He punches buttons, and more diffraction patterns of organic molecules appear on the screen. They look like dancing wedding rings, solar eclipses, radioactive hula hoops, the planet Saturn. The scintillating colors represent the intensities of the X rays diffracted from various parts of the sample. "You can work with images on the computer in many ways—for instance, blowing them up to look at the details in a particular region," Caffrey says. With such techniques he can even study a cell membrane, creating pores through which hormones and other substances can move. Using CHESS's pulses, he can take snapshots, watching the processes in action.

To simplify what he sees, for the benefit of nonbiochemists, he has drawn a cartoon of a cell membrane, in which peanuts form the inner and outer skins, with protein molecules sitting like plump green peanuts between the two layers. The proteins he draws are smiling. Upon the addition of calcium, however, the lipids in the cell membrane flow together, making the membrane stiffer. Frowning, proteins march away from the stiffened area in a huff. "The proteins don't like that; so they bunch together in a separate part of the membrane, acting as a pore," says Caffrey.

Producing the X ray diffraction pictures he works with might require 12 hours using a conventional X ray source, with CHESS it takes only seven minutes. "And people using conventional X rays are goggle-eyed at the quality of this material," he says.

Synchrotron radiation already is increasing our understanding of atoms and molecules, eventually it may save lives. That is the aim of Bill Thomlinson, a Brookhaven National Laboratory physicist, and John Hui of the department of surgery at the State University of New York at Stony Brook. Once a physicist working with Nobelist Brian Josephson, Hui switched to surgery when his father died of a heart attack. He hopes to reduce the danger of heart disease.

In fact, Thomlinson and Hui intend nothing less than turning synchrotrons into huge X ray machines for heart patients. Precisely because it is so intense, they say, synchrotron radiation will be safer than current techniques for X-raying the heart.

Right now, heart X rays require massive doses of opaquing fluid, like iodine, to be injected directly into the coronary artery. Massive doses of fluid are required because ordinary X rays are so weak. Without the iodine, X rays would pass right through the soft tissues. The injections are so dangerous, however, that physicians recommend the procedure only for patients who already have strong symptoms of heart disease. Also because of the constant beating motion of the heart, ordinary X ray pictures tend to be blurred.

"We think we can get around a those problems w th the synchrotron," says Thomlinson. Because synchrotron X rays are so powerful they can be tuned down to just one narrow frequency range and st ll retain plenty of power. Iodine, says Thomlinson, absorbs the rays at a partic- u ar frequency. Thus, doctors can tune the X rays to iodine, and that means much less is needed to produce h gh-qua ty heart X rays. In addition, synchrotron rad at on can freeze the heart's beating motion and take blur free pictures.

Thomlinson and Hu hope to see ent re synchrotron fac lities dedicated to heart X rays. To such fac lities would come people with no symptoms of heart disease but at high r sk because of fe sty e, heredity, or medica history. Synchrotron X ray centers would make it possib e to study whether precautions l ke ow-cho esterol d et and regu ar exercise rea y can prevent heart d sorders. R ght now there are no data whatsoever. Research could prove or d s- prove the benefits," says Thom nson.

Another poss bil ty, suggests Hu is *in vivo* m croscopy. Now we take t ssues out of the body to test them ' he says. But what f we could do microscop c studies ns de the ving body?"

He sees an even more futur stic use: X- ray holography. "We could use synchro- tron X rays to produce a three-d mens onal view of the whole body," says Hu. Sur- geons coul d examine an mage of the beating heart n real time, wa king around the organ to study t from all sides.

Because of such poss bil t es, synchro- tron radiat on s one of sc ence's r s ng stars. Bes des CHESS, the Un ted States has fa c lities at Stanford University, at the Uni vers ty of W sconsin, and at the new Na t onal Synchrotron L ght Source at Brookhaven Nat onal Laboratory, on Long Island. The government is planning to build yet another synchrotron source at the Law rence Berkeley Laboratory, n Cal forn a, emphasiz ng the u travio et and soft (ess intense) X-ray end of the e ectromagnetic spectrum. Though many sc ent sts are grumbling that what the country really needs is another source at the h gh end of the energy spectrum, Thom nson notes, "At least the Berkeley pro ect shows that synchrotron rad at on is here to stay."

f divers ty is any measure of scientif c merit, researchers will be sign ng up for X- ray ports for a ong t me. Cons der a sam- p ing of the exper mental subjects nves tigated at CHESS in recent months: alloy structures, how ant cancer platinum drugs work, automob e-exhaust cata ysts, ex- amination of DNA, prote n dynamics, study of aser annea ing n doped sil con, struc- ture of spher ca v ruses, chemistry of coal liquefaction, radiat on damage to l ving tis- sue, the structures of lipid membranes in ce ls, and the mechan sm of vis on.

"The excitement for me is that I can see it s go ng to be a tremendous tool," says Bor s Batterman. "Th s s the biggest damned X ray tube you can have."

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INTERVIEW

CONTINUED FROM PAGE 75

ing organisms, the reasoning suddenly undergoes a flip-flop The whole reductive materialist philosophy of twentieth-century science is based on this flip-flop error a failure to adequately credit the nonmaterial elements in reality. This is how science has misled itself and our culture into the excessive emphasis on materialism

Omni: But how would this concept of modified vitalism alter scientific thinking?

Sperry: Among other things, the theory holds that most of the atoms on our planet are primarily moved around not by atomic or subatomic laws and forces as quantum physics would have it, but by the laws and forces of classical physics biology, geology meteorology, even sociology politics and the like For example, the molecules of higher living things are moved around mostly by the living, vital powers of the particular species in which they're embedded They're flown through the air galloped across the plains, swung through the jungle, and propelled through the water not by molecular forces or quantum mechanics but by specific holistic, vital and also mental properties—aims, wants needs possessed by the organisms in question Once evolved, the higher laws and forces exert downward control over the lower

Omni: Do you see applications also in physical science?

Sperry: Oh, yes, in the relation of quantum mechanics to classical physics, for example. When physicists found that classical Newtonian laws no longer worked for elementary particles but that a new theory quantum mechanics, did, they abandoned support for the old Newtonian doctrines in favor of the new quantum theory The new theory was taken to be a better and more accurate description of nature

As we see it now, this was a mistake There's just no way quantum mechanics could replace classical mechanics for things larger than molecules. Quantum theory can't handle the pattern factors that the classical laws naturally incorporate Neither is wrong We need both but for different things

Omni: Popularized accounts of the new physics imply a less mechanistic and nonmaterialist kind of reality drawing similarities with Eastern religions Do you see common features with mentalism?

Sperry: Well, not really In my thinking it's not legitimate to extrapolate from the nature of subatomic events to the world at large. The emergent entities at higher levels contain envelop and control the properties and expression of the elementary particles So the common world is better described in the framework of the old classical Newtonian physics, plus biology geology, and the other sciences The world is not all dancing energy or "charm" just because the ultimate building blocks seem to be of this strange and elusive nature

Omni: Aren't you coming back to the initial impressions a nonscientist would probably get under ordinary circumstances?

Sperry: Much of it had seemed a matter of common sense until science came along and began telling us otherwise Ever since, there's been a growing conflict of culture and world view between scientists and the rest of society, felt most keenly in the humanities and especially in those disciplines most concerned with moral values Perhaps what I'm saying here, in effect, is an admission The humanities and common sense were on the right track all along, and we in science were misled

Omni: Looking back yours is not the first attempt at a value system based on science. How does your proposal differ from that of Karl Marx or French biochemist Jacques Monod or others?

Sperry: I think they were misled like most of the rest of us were earlier They accepted science as if this meant embracing the philosophy of materialism and the interpretations of human nature and society that this implies Marxism upholds values and a world view that are radically opposed to the ones that would emerge from a system based on science as we now understand it In Marxism, what counts in shaping the world and human affairs are the actions man takes to fulfill his material needs But this overlooks the key principle of downward causation Under the mentalist view the higher idealistic properties that have evolved in man and society can supersede and control and take care of these more primitive needs

> *"The higher order mental processes move their neuronal details much the way different program images on a TV receiver determine the pattern of electron flow on the screen"*

The espousal of science by the Marxists, Monod, and many others including today's secular humanists has usually meant also the rejection of institutional religion. This, I think is a mistake, especially with world conditions as they are We need to raise our sights to higher values above those of self-interest, economic gain politics and daily needs for personal subsistence to higher more long term, godlike priorities. This isn't something the human brain does naturally or easily. It helps to have the continual reminders, influence and teaching of people and institutions professionally dedicated to cultivating these higher perspectives

Omni: But don't you think that a merger with science places excessive restraints on religious doctrines?

Sperry: In the past under the materialist philosophy, perhaps it would have Past efforts have been one-sided asking in effect that religion mend its ways to conform with the facts of science, but with no similar request the other way around. On our present terms, it becomes a compromise Religion gives up dependence on mystical concepts, whereas science gives up much of its traditional materialist legacy

Omni: If science is to be a greater force in religion, do you think a naturalistic and higher mental view of man's creator would leave us enough to believe in and revere?

Sperry: Yes but this gets into matters that are best left to theology That's why we need a partnership

Omni But would the scientific view leave something that theology could really hope to live with?

Sperry: I think so, on our present terms Remember that along with the human factors the scientific view includes the cosmic the subatomic, and everything in between—the entire evolving web of all creation and the whole matrix of forces involved. No one has yet described anything that even remotely compares in vastness complexity, diversity and awesome beauty It's certainly something to revere

One can even look at it the other way around as an overall gain for religion—just as when mankind gave up the belief that the sun was driven across the sky each day by Apollo in his chariot of fire. We now think of the concepts that replaced that as an advance not a loss

Omni: But does visualizing God in this way leave anything to satisfy personal emotional needs like loneliness and despair as faith in a personal deity does?

Sperry: It would depend There's nothing wrong with personalizing a difficult concept if one realizes what he's doing and doesn't take it literally—especially in the privacy of one's own belief, where it doesn't harm others

Omni: When you refer to a new world view in science, you include truths, such as insights about human values, that have been contributed by the humanities

Sperry Strict separations don't hold anymore I emphasize science because of its rigorous standards for validation Also science, like revelation, takes us beyond the bounds of ordinary experience. Science gives deeper insights into the nature and meaning of things It helps clear the mystery and show the way it enables us to get a better and more intimate understanding of the forces that made move, and control the universe and created man

Omni: Where do you stand then on claims of religion based on revelation?

Sperry: Revelations are fine. We use and welcome them in science. Whenever you become intensely wrapped up in a prob-

em over a long time, it can become part of you. It gets ingrained in the subconscious so that sudden breakthroughs may almost seem to come from somewhere else. Of course, science throws away many of these revelations when they fail to hold up under experimental test. That's the crux: the double-check against outside reality.

Anyone who has studied the brain—its inputs, outputs, the way it works, and so on—doesn't trust these inner workings without some kind of validation. The human brain can easily go wrong by itself. You can let your internal logical processing run loose and arrive at all kinds of rationalizations. That's the nature of the brain. It has a built-in logical processing system, and it picks up reasons for this and that, but such logic is not always airtight. You can come up with all kinds of wonderful, wishful thinking conclusions, entirely novel concepts made up just of the brain's own runnings. Science gets around this by demanding that the brain process check and double-check with outside reality. That's the difference between science and other sources of belief.

Omni: Your book suggests that an ethic based in science might work for the United Nations and world government.

Sperry: Yes. Much of the difficulty in getting agreement for world government is that peoples of differing faiths and cultures don't want to be governed by the values of opposing ideologies. Capitalist countries don't want to have to submit to Communist values, or vice versa; the same applies to Christians and Muslims, and so on. There seems little chance in the foreseeable future that all the different countries will agree to give up their beliefs to unite under the ethical principles and values of any existing ideology. One can imagine the possibility, however, that all countries might be willing, for purposes of international law to compromise on a new, relatively neutral ethic founded in the truth and world view of science.

Omni: Is it wise to try to plan and direct a shift in values? Values usually change under the pressure of practical reality, when conditions reach what you've called the "margins of intolerability."

Sperry: Well, you can go this way letting world conditions force the new values, but by the time this course takes effect, it'll be too late. Availability of basic resources per capita is already going down. The law of diminishing returns is evident everywhere. Species are being eliminated in alarming numbers every year. The dignity and meaning of life for minority creatures around us are almost gone already. The longer you wait for deteriorating conditions to force a value change, the worse the residual quality of our biosphere.

I'd rather go for ideals. I don't like to think only about a sustainable society—how many masses the world could sustain in terms of agribusiness, fisheries, and remaining topsoil—if we could get all of our technology working right. I'd much rather calculate what the ideal population would be to make the life experience the best, most beautiful, and wondrous overall.

Omni: It seems many scientists turn their attention to global and philosophical problems as they get older.

Sperry: As most scientists age, they see the end approaching, and they no longer have the patience to waste their time on the kinds of things they thought they could once do forever. You raise your perspectives with age. I don't think this is something to be ridiculed, as many scientists are inclined to do in their younger years. It's something to be fostered and valued—put up rather than put down.

Besides it's the young people today, thinking young people who are most concerned about these questions. They're the ones who are most affected and are afraid that in five or ten years we're all going to be dead. When my generation was growing up, this wasn't a concern. We had a future, hope, and heroes. The great cities of the world were still great, and things and people weren't so expendable.

The human brain has tremendous power to become adapted and habituated. Unless you're old enough to have experienced the ambience of earlier times, you don't have much basis for comparison, and you don't sense what has happened. But these days any adult of any age ought to be concerned about global problems. It's just a matter of looking around.

Omni: Does the rationalist mystical approach you advocate leave any room in one's life for realms of the irrational for fantasy or profound transcendental mysteries beyond the reach of science?

Sperry: Oh yes, definitely. I certainly don't think science covers everything, or has all the answers, or dogmatically proclaims a final, absolute, or infallible truth. The more we learn, the more new mysteries we uncover. The argument says nothing against mysticism, fantasy, and the like in art or drama, for example, or in the private sphere or anywhere else where it doesn't influence the laws we're governed by. This is where my concern lies: with those social values and beliefs that directly or indirectly get written into constitutions, manifestos, laws of the land—and perhaps future laws of the planet itself.

We have to remember, too, that strict separations don't hold anymore. The views of science fuse with religion and are on a continuum with the humanities. The two-cultures conflict resolves, and the way is open for the three disciplines to work together. Like everything else today, even the desirable irrationalities of life—the mysteries and the magic—need more rational protection. It's just that with everything considered, it would seem safer for our children's children if we didn't continue to gamble the world's destiny on conflicting mystical answers anymore—or on outmoded materialist ideologies. ∞

"Six weeks at bartender's school at the club's expense, and he still can't make a decent martini!"

CHILD

CONTINUED FROM PAGE 88

where the dinosaurs left off. Intelligence kept increasing at an ever-accelerating pace. The original actors, the dinosaurs, were replaced by a second string of actors, the mammals, who continued the old drama and haven't finished yet.

Whether you're talking about dinosaurs or mammals, Russell notes, a single biological species has never lasted more than several million years. Yet, brain size has increased steadily, despite the replacement of old species by the new. Humans, as we know them, aren't likely to last any longer than other species, he adds. "But from what we know about the evolution of complexity, I see no obvious impediments to humans giving rise to another species, one that is still more highly evolved. If humans follow the pattern seen in the evolution of other organisms, that new species could be a humanoid creature with a larger, more complex brain."

The possible facial features of Russell's large-brained creature have recently been suggested by Robert Shaw of the University of Connecticut at Storrs. Shaw's work with computer graphics shows that if the human brain grows larger, the corresponding face will have the neotenic traits—round cheeks, small lips, receding jaw—that were predicted by Boaz.

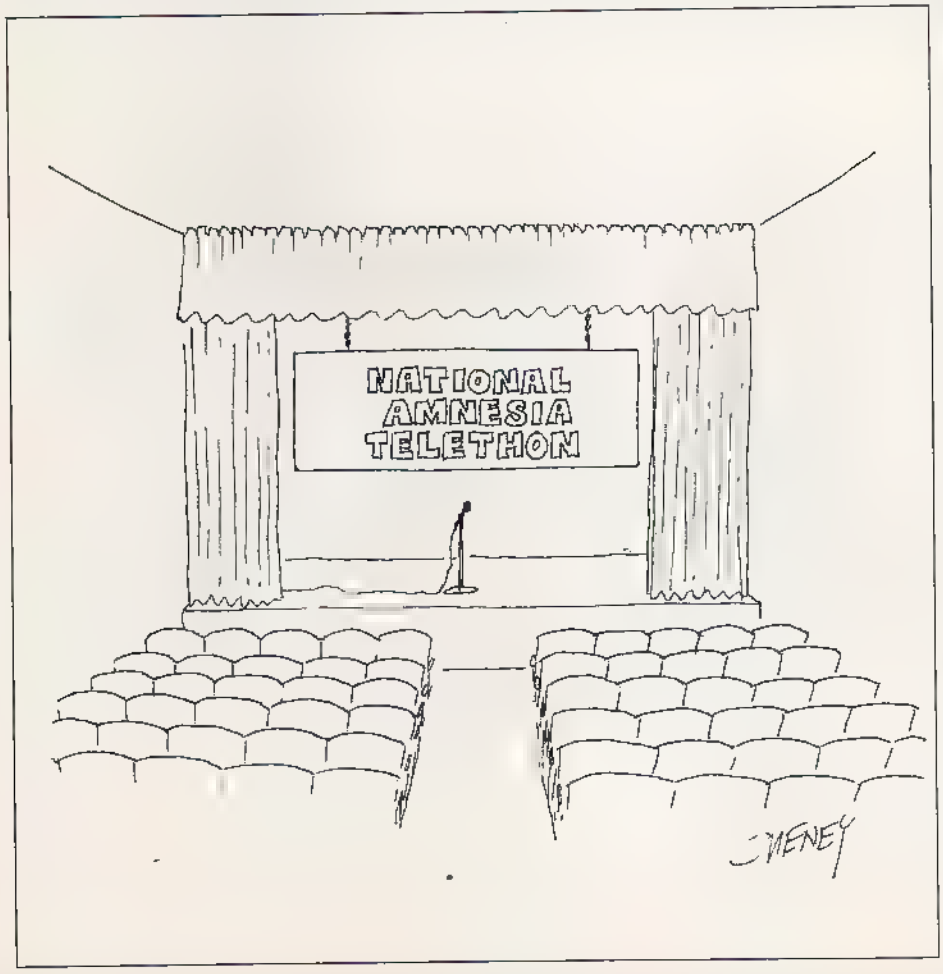
Shaw, a cognitive psychologist, began studying the human face to learn what features our eyes latch onto when we recognize a friend. "To do that," Shaw relates, "I had to determine the crucial components of the face. That meant learning just what a face is and exactly how it develops. I thought the best way to study all the elements would be to watch faces generated on a computer screen."

Shaw went on to create a computer program describing how the human face develops from birth to adulthood (about the age of twenty). Proceeding on the theory that growing facial bones were influenced primarily by the force of gravity, he found that if he started with the face of a normal baby, then applied his special gravity model, the computer face always retraced human development in a matter of seconds. As the white-lined profile on his screen went from infancy to adolescence, the cranium shrank, the forehead narrowed, and the jaw expanded. The program, it turned out, described facial growth better than any other.

One day, on a lark, Shaw and co-workers (including John Pittenger, Jim Todd, and Leonard Mark) instructed the face on the computer to keep developing beyond the age of twenty, when human-bone growth usually comes to a halt. Says Shaw: "We thought that by telling the computer to push bone growth beyond the point of complete maturity, we'd generate some kind of monster. But to our surprise, the face became increasingly primitive. It took a few minutes for me to realize we were generating images of our ancestors. Instead of mimicking aging, the program was now going back through what seemed like the stages of evolution. In essence, it was portraying what might be called *devolution*. The twenty-year-old *Homo sapiens* turned into an individual resembling our ancestor *Homo erectus* and then into a humanlike creature more primitive than that."

The program's ability to retrace evolution, Shaw thought, was explained if one defined evolution as growth that occurs over eons. If devolution could be simulated by excess maturity, he reckoned, it might be possible to simulate future evolution by making the image increasingly immature. To do that, he started with the image of an ordinary *Homo sapiens* infant and told the computer to make it younger and younger. He entered the appropriate equations and, to his amazement, the infant's forehead bulged and the jaw receded until it was tucked behind the nose. "It resembled your typical extraterrestrial: big brain, big eyes, and all," he recalls. "The suggestion was that evolution might create large-brained, baby-faced adults."

In his next experiments, Shaw went on to demonstrate just why these baby-faced adults would be likely to evolve. First, Shaw and his student, Thomas Alley, used the computer program to create pictures of children with a wide range of head and face proportions. The result? Human subjects viewing the pictures reported a protective response toward children with larger foreheads, rounder faces, and smaller jaws—children who looked younger for their age. Then Shaw's associate Vik. McCabe, who examined pictures from the Los Angeles County sheriff's department, found that battered children were usually more adult looking than their well-protected siblings. The disturbing implication: Neotenic-looking children inspire more tenderness and thus have an evolutionary advantage even today. If natural selection is in fact a force to be reckoned with, then neoteny's child will probably be the one most likely to survive.



Before the juvenile inherit the earth they'll need at least a million years to complete their evolutionary odyssey. Unless scientists learn enough about the process to create the new species ahead of time.

One man who can't see waiting for evolution to unwind is anthropologist William Chmerny, of Idaho State University. Chmerny became fascinated by neoteny as a graduate student in anthropology, when he "had more trouble mastering Spanish than a mere child would have." Chmerny realized that children absorbed not just a second language, but even a third or a fourth with ease. It dawned on him that geniuses like Mozart and Einstein had produced their major work before the age of thirty, when the brain is still deve-

oping What's more, he recalls 'I knew that children had six or seven times more dream sleep than adults, giving them extra hours to make sense of all the data they absorbed during the day

Chmerny's observations convinced him that if he could render the brain permanently 'childlike creative intuitive and rich in dreams human intelligence would know no bounds After years of studying evolution, he felt he might best achieve this end by artificially accelerating neoteny Before he could attempt such a thing though he had to know a lot more about how neoteny worked

His biggest clue to the mechanism came in 1974 when California paleontologist Donald Johanson found the three- to four million-year-old skeleton of the protohuman Lucy The amazing thing about Lucy was that she'd walked erect, evolving from her four-legged predecessors in less than a million years A million years, Chmerny knew was a blink of geologic time normally long enough for only about 250 genes to mutate Yet the essential changes in Lucy's brain, muscles and bones should have required millions of genetic mutations, and thus many millions of years

Chmerny faced a paradox, but his avid interest in neoteny quickly presented a solution He knew, first of all, that the juvenile form of Lucy's four-legged ancestor had probably walked erect, just as baby apes do today Suppose he theorized that only those specific genes capable of arresting development—the genes of neoteny—had changed, causing the adult Lucy and her kin to retain the juvenile capability for bipedal walking. If that were the case the change from quadrupedal to bipedal walking *could* be accomplished with a couple of hundred gene changes instead of a couple of million

To pin down the point of change from four- to two-legged walking the first major neoteny event in the evolution of man—Chmerny is now examining human and chimpanzee fetuses. Until about three months after conception, Chmerny explains both species seem to be developing the anatomical architecture for bipedal walking But sometime after the three-month mark the chimp fetus starts developing the anatomy for quadrupedal walking while the human maintains its immature, bipedal form

These different developmental paths, Chmerny believes can be traced to the production of still-unidentified body proteins In both chimps and humans, his theory goes, the genes producing proteins for the juvenile, or bipedal, anatomy turn on and off at much the same pace But in chimps the next set of genes—those producing proteins for the quadrupedal form—take over within about three months, in humans these genes are repressed

By studying development in the fetuses of humans and chimps Chmerny hopes to identify the various proteins involved Then he'll use recombinant-DNA technology to find the genes that produce those proteins. Since both bipedalism and intelligence seem to have emerged through neoteny, he adds similar techniques may help us find both sets of genes

'When we find those genes," he concludes, "we won't have to wait for neoteny to increase the juvenile proteins We'll alter the genes ourselves through recombinant-DNA technology letting sexual maturity progress to completion but keeping part of the brain especially the cerebral cortex, immature Thus," he concludes 'we'll have the best of both worlds an adult body combined with an essentially adult brain that has retained the curiosity creativity and insight of the child.'

Does Chmerny see any ethical problems with redesigning twenty-first-century humans? "Yes," he says. "The principal danger has to do with what you're redesigning them for, I certainly wouldn't want to make better soldiers or better political subjects But if we could expand human potential instead of limiting it then the concept of genetically engineering humans is one I would support."

Though Chmerny still hasn't located the genes that control neoteny, another expert gerontologist Richard Cutler has an idea where they are. Cutler was propelled to the study of neoteny through his lifelong desire to understand and expand human longevity Brought up in a religious home he was taught from birth that he'd be rewarded with immortality if he were good But once he started studying science and evolution he began to suspect that no matter how good he was death was something he couldn't avoid. 'The reality of a finite human lifespan he says "has been with me ever since

"After a while," he adds "I realized that I'd still be in school at the age of thirty and that wouldn't even begin my scientific career until after I reached my biological and intellectual prime. I'd always been interested in space travel, but it seemed foolish to spend all that money getting to other planets if we had a limited lifespan I reasoned that increasing lifespan was the first order of business In the long term, scientific discovery would be far more advanced if scientists had just a five or ten percent increase in health and vigor

Determined to break the life-span bottleneck, Cutler began his graduate training at Brookhaven National Laboratory, in Upton New York Burying himself in books, he soon learned a simple rule of thumb: A species' lifespan always increased as its brain size increased Since the human brain had clearly gotten larger in the course of evolution Cutler concluded 'it didn't seem likely that we'd come from long lived ancestors like Methuselah Human lifespan had not decreased through the millennia, but rather, must have increased at an ever-quickening pace "

Because the increase in brain size and lifespan had been so rapid, Cutler like

Take no notice, he's hooked on tranquilizer darts "

Chimerny, believed that no more than a couple of hundred genes were involved in neoteny and hominid evolution as a whole. As generations passed he theorized these relatively few genes had begun to work overtime, stretching out every stage of development from childhood to puberty to the years of decline. Because development slowed, brains had more time to grow larger, and adults came to resemble the children of their ancestors. To Cutler this made exquisite sense. If a large-brained creature had a longer childhood he'd have more prime years to explore and learn. With a longer period of adulthood, he'd have more time to refine and apply that knowledge. Hence, neotenic individuals with larger brains and longer life spans would have a better chance for survival; their progeny would always prevail.

Cutler began a serious quest for the neoteny genes at Baltimore's Gerontology Research Center in 1976. There, with his wife serving as lab technician, he developed his plan of attack.

Aging, he reasoned, was instigated by advancing stages of physical development, but it also took place day to-day because of toxic particles released as the body metabolized food and oxygen. Dozens of natural enzymes, Cutler knew, protected the body against these poisonous particles, and humans, with their long life spans, had more of these enzymes than other mammals. In fact, by comparing humans with twelve primate species, he calculated that the enzymes had increased in direct proportion to advancing neoteny. The connection was so striking, in fact, that the antitoxin genes and the genes of neoteny seemed to be in some way connected. Cutler even thought they might literally be strung together, forming one huge neoteny supergene coding for upright posture, longevity, and intelligence.

Cutler's dream is doubling or tripling life span by altering the genes of neoteny. The neoteny gene group, he feels, probably encompasses the DNA coding for the antitoxin enzymes. Thus, if he can locate the antitoxin genes (possible through years of work with recombinant-DNA technology) he feels he may find the neoteny genes coding for longevity and brain size as well. Altering those genes in a fertilized human egg, Cutler adds, would be tantamount to creating future man.

Though Cutler concedes that such a task might take centuries, he's already sketched a version of our human descendant, *Homo sapiens futurus*, based on his work in the lab. When the crucial genes are altered, he explains, futurus will be born after a nine-month gestation. His head-to-body ratio somewhat greater than the infant's of today. He'll reach sexual maturity at twenty-eight and grow until age forty, when he'll have a head twice the size of ours. He'll also have a taller frame to support his mammoth brain. He'll reach middle age at sixty and die at perhaps two hundred.

Discussing his drawing from the din of his lab, a centrifuge whirring in the corner, Cutler says he sees no specific physiological limit to the increase in neoteny. "We don't yet know," he explains, "to what extent futurus might evolve before a biological restriction is reached. He might easily surpass the two-hundred-year life span and twenty-eight hundred cubic-centimeter brain we're discussing today."

Our future as neonate, of course, is hardly etched in stone. Anthropologist C. Owen Lovejoy, of Kent State University in Ohio, says that although neoteny is one possible evolutionary path, he doesn't see mankind moving in that direction. "Evolution occurs only when those with a particular trait have more offspring than those without it," Lovejoy contends. "I don't see people with greater intelligence having more children. So where's the natural force leading to greater intelligence? As for life span, most people have children before forty no matter how long they live. So unless we intervene, we'll have no particular selection for longevity, either."

Another critic, Jonas Salk (of polio-vaccine fame), believes that the urge to create futurus on our own is misguided. "I don't really see the need for that kind of advancement," says Salk, who's been studying human evolution since the late Sixties. "Even if these genes could be altered and then transferred to a number of individuals, we would still have to rely on the slow process of biological evolution to transform the species. For instance, here at the Salk Institute we created a giant mouse by giving it genes for rat growth hormone. Right now we're waiting to see whether this trait will carry over to succeeding generations. But whether or not it does, I daresay there are mice in the world that will pay absolutely no attention to what goes on here. If we wish to contribute to human evolution, we can do it far more efficiently by improving the state of the world."

Cutler, however, disagrees. "Only a very stupid person would claim we were intelligent and long-lived enough," he says. "People are always saying that if we lived much longer, Social Security would be destroyed, or we'd have more divorces. They think if you want to change our brains and our life span you've got to be a bit screwy. But longevity and intelligence evolved naturally in humans; they are the traits that separate us from the animals. Increased life span and intelligence are part of our heritage, and to me it makes sense that using technology to create more of the same would be even better."

Cutler concludes his speech and rises, anticipating an afternoon in the lab. The discussion has made him flush, but the glow only highlights his thick white hair. He is forty-seven, and as a *Homo sapiens*, his life is more than half complete. But if his ideas are correct, they might buy a bit more time for his descendants, *Homo sapiens futurus*, the new race of man. ☐

"For openers, I'm taking you off Proust and Kafka."

FORUM

CONTINUED FROM PAGE 16

seek a disease to destroy your enemy and against wh ch you can mmunize your own popu ation or on the other hand let us say you seek a proprietary life form that you can patent (the U S. Supreme Court says you can do th s), and your desire is to em ploy this d scovery for the production of a life-sustain ng hormone. Labs to do such things are costly, and most of the people n them go about their work with a decent regard for innocent bystanders

There is no doubt that such labs are extremely busy right now and scrambl ng for talent. At the universities , investigated , found that most of the know edgeable professors were on lucrative retainers paid by corporat ons racing toward that DNA pot of go d. The r goals are extremely exciting a tomato plant whose roots will produce their own nitrogen, miniature cattle with very high milk product on, regrowth of amputated imbs, and so on. The bacteria production of insu in a ready has been solved through recombinant DNA The economic rewards are enormous, and the fees paid to the academ cs reflect th s

Those high retainers and the urgency of the compet tion are part of the inf ated cost est mates but it shou d be obv ous that I am speak ng about something qu te different In the arena where I want to focus your attent on, high cost assumptions are dangerously delusionary And don't make the m stake of thinking that only a few h gh priests of science can do these things

It took me about a year and a half to become what one of my sources calls a competent amateur in recombinant DNA The information was available 'n med ca ibrar es at univers ty bookstores, from the pub shers themselves and from some of the workers in the field. Adm tted y, I d d not beg n from a posit on of tota ignorance, but t was clear to me that a reasonably intell gent person cou d follow a s mi ar trai without productive diff cu ty

When t came time to cons der acquis tion of the necessary equipment inves t gated the means I have discussed above First though I conducted an exper ment Taking a read y available source book on sc entific equipment, I telephoned suppliers, ident fying myse f as 'Dr. Herbert In each instance, I asked what my "pur chasing department" would have to do to acqu re the needed tem The answer was universal: "When your check has cleared, we w l ship "

Lest you think I am argu ng that "we shou d do someth ng about all of this," let me caution you to think very careful y about the consequences. I find very little wrong with an open market in such equipment and supp es What we need is not less research but more much more Clamping a lid on recomb nant DNA research, con trol ng and l mit ng it, is an attractive but l usory path to security We wou d be certain thereby to conf ne the most dangerous recomb nant-DNA efforts to the m l tary to criminals (inc ud ng terrorists), and to the nsane H story reveals that these have not always been mutually exclus ve labels

Some contro s may be ind cated, but keep in m nd that they guarantee noth ng Implementing contro s of equipment and materials at the sources the f rst th ng many peop e suggest gnores the reality of our mmersion n a technological society where raw mater a s and knowledge are so w de y avai ab e that virtual y any necessary equipment can be dup cated in secret And who s going to keep you from fermenting beans in your k tchen?

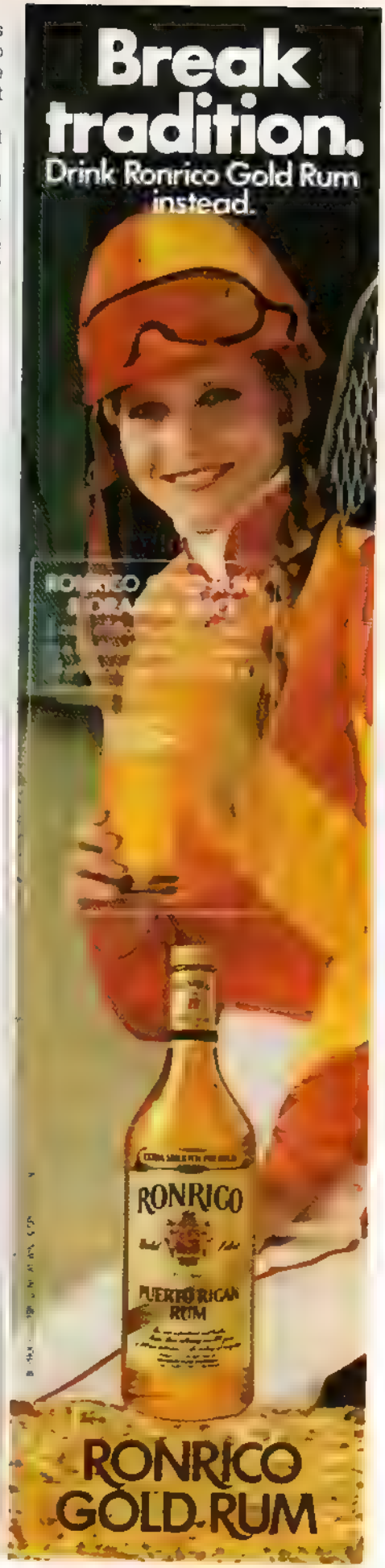
t m ght be wise to take a bu ding code approach to those labs known to be en gaged n recomb nant DNA research We cou d draw up a code of precautionary solation for the known aboratories—negative air pressure w thin the labs, c ean locks with steriliz ng atmospheres, separation of clothing used within the labs and outside them so ated and steri zed waste dis posal—th ngs of th s nature Such precau tions inclu d ng oversight committees composed of scient fic peers, make a certain amount of sense but they do not in sure aga nst acc dents and they certa nly do nothing about those who choose for whatever reason to gnore safe practices

The safest place to conduct such work s, of course off th s planet n space but that poses other problems and does not appear to be immediately feas ble

Our d sastrous exper ence trying to keep harmfu habituating narcot cs out of our country shou d teach us we can prom se no absolute control w th any pol cing system Police can be bought Border guards can be bought Envoys with their untouch ab e d spatch cases can be bought Power and r ches can penetrate our barriers and where narcotics are concerned do so with disgust ng ease Let me caution you here that the power and wea th ava lable through recombinant DNA make the illegal-drug trade look penny ante by comparison

There's no sense in decrying the fact that Pandora s box s open It has been open for a long t me We and our descendants if we're lucky enough to have any, must make our way n a un verse where terrible threats and magnificent benef ts arise from the same knowledge Some of us seek to improve our surv val ab l ties Others are all too eager to spread poisons A sane society would meet th s prob em on at least two fronts — expanding our exp oration into dangerous knowledge and at the same time, reth nking the ways society is organized In th s way it can un derstand how such perilous condit ons cou d ar se Our best hope now is to mount an a -out effort to earn everything we can about the DNA codes w thin a life forms W th such know edge, we stand some chance of contin ung our species W thout it, we cou d join the d nosaurs

Frank Herbert
Port Townsend WA ∞



CRADLE OF MANKIND

EXPLORATIONS

By Delta Willis

The Great Rift Valley is nothing if not great—a huge ragged scar that carves through seven countries, the result of a nasty fight among earth, wind and fire. This 2,000-mile-long gorge stretches all the way from the southernmost tip of Turkey to Mozambique, and on a clear day it is visible from the moon.

The rift began when the earth's crust pulled apart from east to west, creating huge craters that filled with water. The lakes, and the profusion of greenery on their shores, attracted our early ancestors, the hominids. Aptly christened the "cradle of mankind," this special corner of the globe is a gold mine for paleoanthropologists. Their treasure hunt has been made easier by the earth's continuing change, for the action of shifting faults and eroding winds and rains has exposed long-buried skeletons. The last ten years alone have witnessed a dramatic increase in discoveries. South of Lake Turkana in the Samburu Hills near Baragoi in Kenya, fossils thought to be 8 million years old have been unearthed. Farther north along the rift in Ethiopia, Lucy was discovered, challenging our assumption that the enlargement of the brain preceded the development of a two-footed gait.

Yet even under the best conditions the chances of finding anything of significance is small. Only bones that have been immediately buried by sediment, by accident, by flood, and by chance might fossilize. Most are scattered by predators, ravaged and beaten by wind and time. So what we know of the story of human evolution is based on very little evidence, and never have so many said so much about so little.

Being a human and trying to comprehend the vagaries of human evolution is analogous to attempting to understand how the brain works using the instrument at hand. We are biased observers, and the evidence would defy Sherlock Holmes. But in Kenya there are footsteps to follow and telling clues to ponder. The name irrevocably linked to the search for human origins is the late Louis S. B. Leakey. A legendary pioneer, he popularized paleoanthropology and inspired many students, including leading primatologists Jane Goodall, Dian Fossey, and Biruté Galdikas. His seventy-year-old wife Mary, the respected matriarch of Olduvai, Tanzania, continues to make remarkable discoveries. Their son Richard not only continues the legacy but enhances it overseeing all of Kenya's archaeological research as director of the country's national museums.

The plural, museums, is correct, for Richard Leakey has established a series of annex museums and protected excavation sites throughout the country. The sites are reasonably accessible from Nairobi and invite the ultimate quest for roots. It is a little-known journey and unlike other safaris, the animal under pursuit has long been extinct.

We seek evidence of a creature that evolved from shuffling apelike beginnings into a highly complex, upright primate. We seek to understand the beginning of being human.

To start, one must imagine the unimaginable: the long, uneven calendar of prehistory; an ancestor who is darker, shorter, cruder, but—just possibly—not at a loss for words. Once we've got the time and characters, we must fathom the setting itself, the Great Rift Valley.

Besides the moon, the window seat of a plane offers the most breathtaking view of the cradle of mankind. From the air, the sunlight catches the curves of the Kenyan lakes Turkana, Baringo, Nakuru and Naivasha. These bodies of water were once surrounded by true gardens of Eden at the dawn of man. Every feature in the landscape below—jagged escarpments, volcanic cones, craters—plays a role in dating the chapters of evolutionary history.

Once in Nairobi, the first stop should be the National Museums of Kenya, on Museum Hill Road. Exhibits include reproductions of exquisite cave drawings from Tanzania, which depict humans and animals nearly 35,000 years old. There is also a life-size floor cast of the footprints that Mary Leakey discovered at Laetoli, in Tanzania. These imprints

From a Kenyan roadside skirting the Great Rift Valley, an invitation to explore human origins

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AirCarel	236,000	YES
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which look almost as fresh as the day they were made, indicate a commitment to bipedalism at least 3 million years ago.

Appropriately adjacent to the main museum is the Louis Leakey Institute for Prehistory. Housing the museum's departments of paleontology and archaeology, the Institute is home to an impressive collection of ancestors including *Australopithecus boisei*—dubbed the "Nutcracker Man" because of its huge teeth—and 1470, the museum code for Richard Leakey's *Homo habilis*, or "Handy Man," which is the oldest complete skull of early man. But the real adventure is on the road, over the edge of the Rift. You can fly or drive to various dig sites, and nearby there are very reasonably priced cabins, or "bandas," for overnight stays.

For the intrepid, I recommend driving south around the famous Ngong Hills and down an escarpment that rivals the Grand Canyon in beauty and beats it, several times over, in size. You can study the faults, the craters, and the changes in the soil while you reconstruct history.

The road from Nairobi to Magadi finds Olorgesailie midway, a rugged, arid basin that half a million years ago, was covered by a lake and surrounded by swamps and a grassy floodplain. The mind's eye resists such a notion because the sun has burned all the color out. The landscape is as bleached as an overexposed picture. A tall, swaying dust devil, swirling its way across the basin, mocks any suggestion of water in the history of this land. Yet proof lies beneath the glare of the earth within the vast depression. At least two shades lighter than the surrounding soil, the evidence is a dull white diatomite that crumbles in your hand to reveal silica shells of aquatic plants.

In stark contrast to the white diatomite, red fault beds trace the collapse of the Great Rift Valley, whose western ridge can be seen 30 miles away. One day long ago, at Olorgesailie, the earth pushed too far, and the southern edge of the basin fell, inviting flood. Our closest hominid ancestor, *Homo erectus*, must have eaten and run, for he left behind tools and an unfinished dinner. The sediments of the flood buried the scene for more than 100,000 years, until Louis and Mary Leakey in the 1940s, began to ex-

CONTINUED ON PAGE 120

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EARTH

CONTINUED FROM PAGE 18

was right in front of him. If he could model tractor wheels so they'd provide flotation like the broad, flat feet of the water buffalo, he'd be home free.

Teparit soon found he could duplicate the ability of the water buffalo with paddle wheels that resembled those of a Mississippi steamer. He hooked the wheels to an eight-horsepower engine, creating a power tiller that chugged through the mud. He worked on his design for five years and in 1946 introduced the Iron Buffalo, a machine that traversed the paddy seven times faster than its animal counterpart. By 1950 news of the vehicle had spread throughout the countryside, and Teparit spent the next decade establishing workshops so farmers could adjust the paddle wheels to the soil of each particular region.

By the early Sixties, Teparit explains, he was ready to embark upon the next stage of his revolutionary plan: developing pumps that could empty and fill the rice paddies, eliminating the need to transplant seedlings and permitting three or four crops a season instead of one or two. In 1968, after he'd lost two fingers experimenting on the design, he announced the completion of the Teparit Pump, a long blue tube powered by the motor of the Iron Buffalo itself.

Satisfied with the decades of accomplishment, Teparit settled back to enjoy his wife and five children. But King Bhumibol insisted there was still one problem left: The country's intractable drought. "They make rain in America and Australia," Bhumibol told his cousin. "I want you to learn to do it too." With those words, he gave Teparit $85,000, two single-engine Cessnas, and the title of Royal Rainmaker. Then he ordered him to work.

Excited by the challenge, Teparit began researching all past rainmaking efforts worldwide. He found that most rainmaking had been done in colder climates, usually by seeding clouds with the compound silver iodide. But when Teparit sprinkled silver iodide particles on the sweltering clouds over Thailand, it didn't work. He and his team then began months of exhaustive tests: spraying clouds with a range of chemicals, from ammonium nitrate and urea to calcium chloride and sodium chloride. Producing rain in the tropics began to seem impossible, until Teparit got an idea. The warm, humid rains of Thailand usually come from the sea; perhaps chemicals from the sea would produce the tropical rain. Following his hunch, Teparit had soon extracted mineral salts from seawater and sprinkled them on the clouds in experimental patterns. Down came the rain.

His tropical rainmaking system has recently spread throughout Malaysia, Indonesia, and the Philippines. With an annual budget of $2 million as well as a fleet of balloons and twin-engine Cessnas, Teparit's Thai team now works mostly during the rainy season, increasing rainfall by 20 percent over 18 million acres of crops and. Other missions have included fighting a Bangkok cholera epidemic by producing rainfall to wash away infected feces, halting the onslaught of Philippine typhoons by making it rain *before* the clouds reached land, filling reservoirs, and clearing the fog over King Bhumibol's helicopter pad.

Today, at sixty-nine, Teparit says that success has not left him unscathed. Adjusting his hearing aid, he explains that his left ear was punctured during a cloud seeding mission by a small sliver of dry ice; his right ear was damaged when an unpressurized plane went out of control.

And, he adds from the swivel chair of his air-conditioned office at the Ministry of Agriculture, he was nearly killed fighting a plague of locusts in 1976. He had been tied to an observation platform at the open rear end of a U.S. C123 transport plane, he recalls, when a 1,000-gallon chemical tank exploded. The crew were afraid to come and untie Teparit; so they flew upward to drain the toxic chemical out of the plane—it simply poured over him on the way out. By the time the plane landed and a doctor raced up to him, his blood pressure was up to 220. That day his spleen was removed, and two years later his gall bladder had to be cut out.

The scars and dangers haven't slowed Teparit down, however, at least not yet. Just last year, in fact, King Bhumibol asked the rainmaker to negotiate with Communist insurgents who were shooting bulldozer crews digging a royal reservoir project.

"The king told me to limp a little when I entered their camp," Teparit says, "but that wasn't necessary. I put leaflets in the towns saying I was coming and wanted to meet their leader. After two months, I was contacted and taken to a meeting place. They had built a wooden platform in the jungle for me to stand on, and soldiers sat around pointing their guns outside in case the army was following. But it was a completely secret operation. We talked four or five times for six or seven hours each time, and they agreed to let the reservoir project go through. The Communist leader—one of the few who has not surrendered in the recent government amnesty—said he built me a house in the woods that I can come to anytime I want."

But Teparit has no intention of retiring to a secret jungle retreat. He's hard at work on his next project: using electricity to extract hydrogen from seawater. The electric current splits the water into its component parts—hydrogen and oxygen. Some of the hydrogen is then burned to create more electricity, and the rest can be used to fuel factories, autos, and homes.

It's been a long time since Mom Teparit got up on a brand-new International Harvester tractor that was so big he couldn't reach the clutch. But as he boards his 36-foot-long hydrogen-powered boat to cruise the Gulf of Thailand in search of energy, it seems that little has changed. ∞

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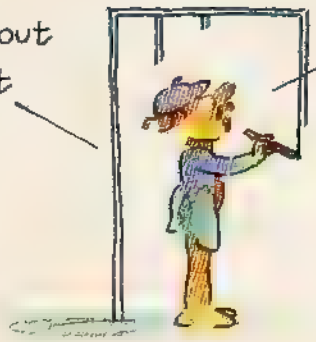

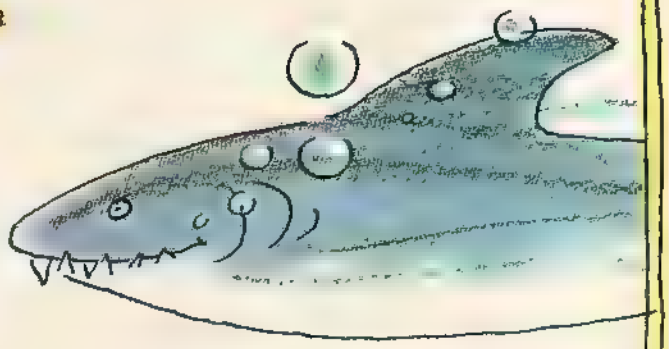

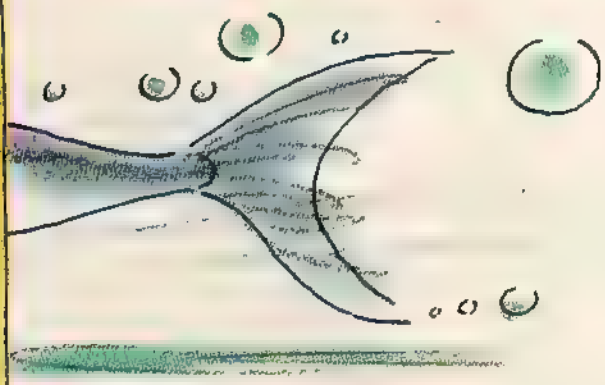

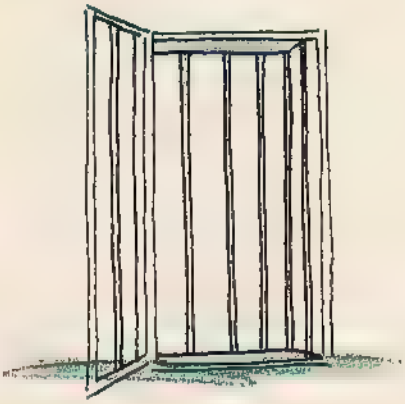

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MIND

CONTINUED FROM PAGE 26

cross-communication, her brain may be more balanced than a man's. In short, women's brains may be less lateralized, or specialized in what they can do.

Some researchers even argue that this could help explain why boys do better in math and spatial reasoning tasks involved in geometry but have more trouble learning how to read. With less communication going on between their hemispheres, men may have the edge on women when it comes to who uses the right side of the brain more exclusively.

In fact, several observations other than De Lacoste's suggest that the sexes are *not* created equal when it comes to lateralization. After a stroke has damaged the brain's speech center, a woman is more apt to recover the ability to speak than a man. In theory, this is because the other side of her brain can take over more easily. Another piece of evidence comes from what we know of human development. The process of becoming lateralized begins in the fetus. At what point lateralization begins is not clear, although in her study of fetal brains, De Lacoste has found structural differences in fetuses as young as 26 weeks. And this process isn't finished until the onset of puberty. Since girls reach puberty before boys do, their brains may have less time to lateralize.

Brains as well as bodies are shaped by sex hormones, so a difference in specialization should not be at all surprising. If a male rat is castrated at birth, for example, his hypothalamus will develop into one that resembles a female's. If a female rat is given the male hormone testosterone at birth, her hypothalamus will take on male characteristics. Remove her ovaries, the source of the female hormones estrogen and progesterone, and the female's cerebral cortex will become male-like.

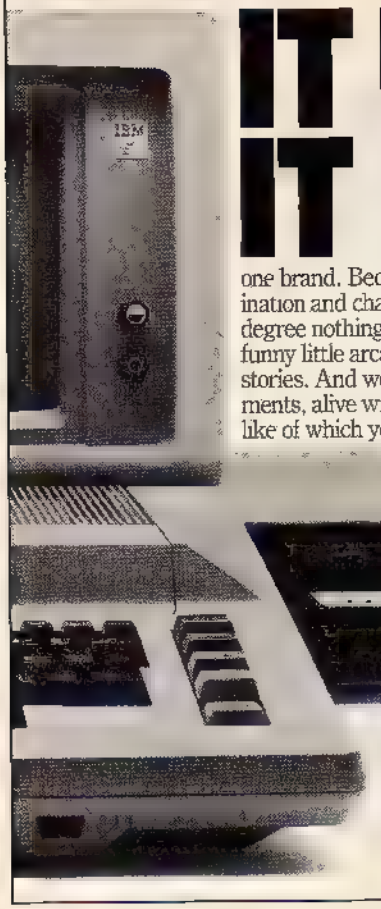
As De Lacoste points out, when the human brain was evolving, males and females occupied different ecological niches. Female hominids gathered food and nurtured babies, males hunted. These activities, each requiring different skills, could have put different adaptive pressures on brain development. Females, for example, may have needed a more integrated understanding of the world, while males might have required more specialized skills like the ability to hold three-dimensional images in their minds (perhaps for mapmaking). Pressures like these, De Lacoste speculates, may have been the environmental forces that shaped women's brains so that they became less lateralized.

But don't misunderstand," she adds. "We don't have two brains evolving separately, just one brain that reflects the differences in sex hormones and reproductive functions." More important, she adds, one should not misconstrue what sex-linked brain differences mean. In itself lateralization says nothing about an individual's innate intelligence and mental capability.

"We're talking about differences in the way men and women screen information," De Lacoste explains. "Women seem to have a bias toward picking up information presented in a verbal fashion; men, in a visual-spatial way. Once information is selected, though, their brains function in the same way with the same potential."

Neither approach is better than the other, says Denmark. "It's assumed that if males have more lateralization, then it's the thing to have. But you can interpret it another way. Perhaps women have larger areas of the brain from which to draw skills."

Ultimately, both interpretations are equally irrelevant, she concludes. Why? Because when it comes to human behavior and intelligence, biology is *not* destiny. "Regardless of structural differences, the cultural factors are enormous," explains De Lacoste. Research shows that our genes may determine which sex hormones course through our bodies, and those hormones may help sculpt our brains. But as De Lacoste points out, it is the constant interplay between this genetic potential and our environment that defines our talents and abilities, and determines what we learn. DO



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HSCA3

LIFE

CONTINUED FROM PAGE 20

information from sequencing laboratories around the world. His effort was officially sanctioned late last year when Los Alamos and a corporate partner, the Cambridge consulting firm of Bolt Beranek and Newman Inc., were awarded a $3 million contract by the National Institutes of Health. The Europeans, in the meantime, had launched their own sequence library in Heidelberg, Germany, and the Japanese had also struck out on their own. "But eventually," predicts Goad, "there will be just one international database, and it logically follows that all the regional branches will carry identical data."

Genbank is open to anyone for a nominal fee. "We play a primary role in helping to keep the information accurate," says Goad. "That's why in spirit we wanted it made maximally available, as cheaply as possible." At present, 25 percent of Genbank's 150 clients come from industry, and another four or five users sign up every week.

"We need reliable sequencing for all the work we're doing, from interferon synthesis to protein engineering," says Robert Schwartz, manager of computer programming at Genex Corporation in Rockville, Maryland. "At last the government is chipping in to help us out in a way the Japanese have been doing for themselves for years." He also notes that the rapid influx of sequences has in turn necessitated the development of higher-level computer programs to search for data correlations that will lead to new discoveries.

To biotechnologists, this resource represents a veritable encyclopedia of genetic cuisine. From computer terminals in their offices and laboratories, they will be able to gain instant access to genetic recipes for numerous body chemicals from interferon to insulin and growth hormone. Alternatively, researchers may make tiny alterations in existing genetic codes to create proteins—even whole organisms—never before found in nature. "In the future," says Christian Burks, a colleague of Goad's, "you could go to your black box, punch in the proper sequences, and out would come a bug capable of breaking down dangerous chemicals. You could drop the bug in New Jersey to clean up the place."

No more farfetched, according to the experts, is the prospect of mapping the locations of all the genes on man's 46 chromosomes. "Within our lifetime," forecasts Genex's Schwartz, "the entire genetic code of a human being will be stored on-line in a room that's filled with spinning disk drives—and it won't be a very big room, either."

Just how this information will be used is anybody's guess. But it is certain to alter how we view ourselves and perhaps even who we are. As genetic librarian Goad points out, Genetic sequences are in some ways the ultimate data. ∞

FILM

CONTINUED FROM PAGE 32

Unfortunately for Superman, what does develop is a bizarre personality change, caused by a dose of Gus Gorman's homemade kryptonite. The man of steel, transformed into a drunken hooligan, must come to grips with himself and then battle a supercomputer (programmed to defend itself at all costs) in a climactic, effects-filled, living video game.

"I think this is probably the most technologically accomplished of the three Superman films," Reeve declares. "I oversaw a great deal of how the flying was to be done, whereas in the first two films I went along for the ride. We have shots in *Superman III* where I actually fly over real city traffic, about four feet above the deck. Long flying shots over wheat fields and real outdoor stuff. It's more ambitious, and yet I feel that the flying has gotten to the point where it's so good you don't even notice it, which is the ultimate compliment. People will see the film and take it for granted. 'Oh yeah, Superman flies, of course.'"

Richard Pryor, not generally noted for any aerial abilities, was also required to be airborne, making for some scary moments for the comedian. Reeve explains: "I rehearsed with Richard in the studio for a couple of days, taking him off the floor slowly first three feet, then five, and then ten, and explained how to fly.

But then the crew got him on the set at eight in the morning, put the harness on and suddenly he was dangling on wires from a crane outdoors. They whipped him up to sixty feet without any preparation. Those construction cranes look flimsy; they don't look solid. It was not a kind thing to do to him. They should have eased him into it. But the scene called for him to be terrified. The unit knew that he was safe and they decided to capture that real fear. Richard Lester is big on that. No one was in danger at any time, but they could have been more courteous to Pryor."

Although the combination of Richards ensures that there is plenty of comedy in *Superman III*, the atmosphere on the set was "not a nonstop party," according to Reeve. "It was professional, it was economical as opposed to what Richard Donner did on the first movie. Donner luxuriated; did a lot of scene painting (the Cheerios on the breakfast table, the unlimited horizon of wheat fields), and then would gradually get each thing go and move on. Lester is not that way. *Superman III* is closer to the second movie. We were moving so fast that when a shot was over, everyone's mind was on the next thing. Pryor picked up that technique. He got to the point quickly, and many things were the first take. Sometimes, though, he can be fishing for two or three takes and then suddenly get it. He's like a flat stone skipping over water; the stone will bounce several times before it goes in. That skipping stone is fun to watch, but you'd better be ready when he hits. The danger is that you'll be off when he's on." Lester encouraged this spontaneity from his performers by shooting certain scenes only once, using several cameras to cover each angle.

The release of *Superman III* coincides with the character's fiftieth birthday, Superman having been created in Depression-ridden Ohio by two teen-age science-fiction fans, Jerry Siegel and Joe Schuster. An escapist and optimistic response to an era of hardship and the fear of war, Superman caught on faster than a speeding bullet after his initial comic book appearance in 1938 and soon spread to syndicated newspaper strips and radio. Film was the inevitable next step, and in 1941 pioneer animators Max and Dave Fleischer earned an Academy Award nomination for the first in their series of 17 color Superman theatrical cartoons. Through the years, the character appeared in two movie serials, a feature film, a TV series, and a Broadway musical.

As the current keeper of the cape in this latest and most ambitious series of Superman movies, Reeve suggests why the character's popularity is stronger than ever. "Because he's such an accurate psychological model. He combines basic fantasy with everyday reality and it's an unbeatable combination. What person who faces the nine-to-five world that we all live in has not dreamed of flying, power, and freedom?" "(Wish I Could Fly Like) Superman" by the voice of England's working class, the Kinks, is one of several recent pop songs inspired by this universally recognized icon. Clichés about X-ray vision and undressing in phone booths are familiar to us all, as is the encapsulated *S* insignia, a motif seen frequently in the mass media.

"Superman is a strong visual representation of a thought common to every citizen of Western culture. Namely: How do I function as an individual in a society where I feel like a mouse?

"However, we mustn't pump this up into being pseudomythology," Reeve cautions. "Superman should be left up on the screen or on the page. The questions that people have come up with about the symbolism of Superman are really quite frightening. Religious figures have called me up and asked if I'm aware of the responsibilities of being a contemporary Christ figure. Hey, I'm an actor from New Jersey. I can't be responsible for that."

Though proud of his work as Superman, the Princeton native feels it's time to move on. "You can't get stuck on any one thing in life. They're planning *Supergirl* now, and we had long talks about how much money it would take me to do *Superman IV*, but I said, 'Don't bother. Money can't buy satisfaction,' and I've got to do movies I'm happy with. I don't want the Superman films to become formulaic. Each of them stands on its own two feet. I hope *Superman III* makes it—it's two hours where you can check your problems at the door."

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FICTION

Dan Simmons's novelette *Carrion Comfort* is a powerful science-fiction horror story set in contemporary Charleston, South Carolina. Three elderly telepaths meet to tote up their achievements—how many accidents, disasters, and personal tragedies they've caused in the past year—and to give a prize to the winner. This chiller makes you wonder whether you're in control of your own life. In the same issue, John M. Ford's "Boundary Echoes" probes the human heart; a musician and a doctor form an alliance to create a highly original chef d'oeuvre. Ford combines science with careful characterizations to create a remarkably moving hard-science-fiction tale.

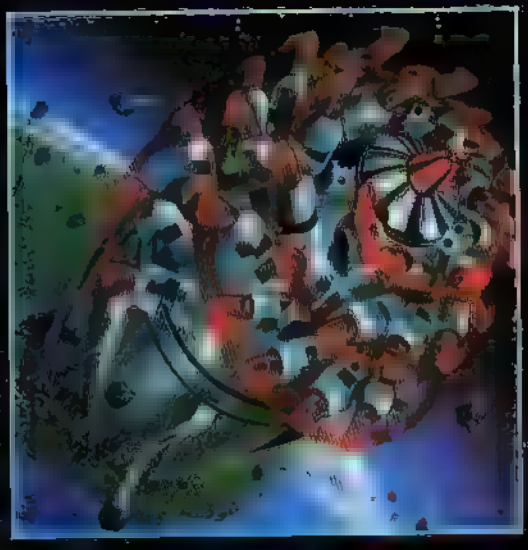
FIREMASTER

Of all the people striking matches today, no one knows more about flames than Norman Chigier. Yet, according to this fluid dynamicist from Pittsburgh's Carnegie-Mellon University, combustion is still a mystery. Chigier penetrates the flames with everything in the high-tech arsenal—lasers, high-speed photography, "hot-wire" microthermocouples, holography. Why? For the next century, he says, 90 percent of our energy needs will come from fossil fuels, and world peace depends on the most efficient use of them. Read about this great quest for flame in September's *Omni*.

SOVIET SHUTTLE?

The delta-wing craft soared out of a dawn sky, heralding its return from orbit with a sonic boom, and then—still glowing with the heat of reentry—splashed into the Indian Ocean. Some said it was a prototype of the Russian version of the space shuttle. But was it really? Careful analysis of flight data and of photos of the craft raised questions about what the Russians were actually testing. James Oberg, a veteran observer of the Soviet space program, explores the mystery in *Omni*.

MACRO



Small may be beautiful, but bigger is better to those accustomed to thinking on a cosmic scale. Imagine an underwater tunnel that stretches from Europe to the United States, a new Great Lake custom-built to supply most of North America's water, a vehicle that carries ships over dry land from one body of water to another. This is the stuff of which engineer's dreams are made, and in the September issue of *Omni*, Frank Davidson, the world's leading expert on macroengineering, describes some of the colossal projects that are well within our power. Also in this issue, you'll learn about the new psychology of sports and how advanced mind-training techniques are helping athletes reach their peak-performance levels more consistently. And you will get a close look at Herman Kahn, one of the most controversial and radical thinkers of our time. Founder and head of the prestigious Hudson Institute think tank, Kahn declares that a Golden Age is coming.

INTELLIGENCE

CONTINUED FROM PAGE 28

house will get its own Cray computer to generate full-screen simulations.

Creating screen-wide computer graphics, believe it or not, takes as many as 5,760 billion calculations for each second of film. Digital Productions has a contract to produce 30 to 40 minutes of simulations for the upcoming film *Starfighter*. Without the Cray the work would take years; with the help of the computer the special effects will be ready in a few months.

Considering their power, today's supercomputers look remarkably simple. A typical Cray-1 is a circle of six foot-high memory and processing units surrounded by a couchlike semicircle. It looks a bit like a high-tech Stonehenge. The circular form is more than decorative. It ensures that no wire in the Cray is longer than three feet. The shorter the wires, the faster the computer can move electronic bits about. But the Cray's denseness produces thousands of degrees of heat, enough to melt an uncooled computer. That's where the couch comes in: It hides powerful refrigerators that remove heat.

Despite these futuristic trappings, the architecture of the Cray—and of most existing computers—is based on the venerable ideas of John von Neumann, one of computerdom's founding fathers. Today's computers use a central processing unit (CPU) to link a few large memory areas with input and output devices. But computer gurus now recognize that future machines will require a wholly new architecture. The problem is that the supercomputer CPU has gotten as fast as it can get. It now represents a bottleneck, a limit on how fast new computers can handle information. "The consensus among computer experts is that desperate further gains to be obtained through the use of new materials and smaller machine geometry. Von Neumann machines are approaching the limits of performance," says a report in *Science*.

The leading candidate for the next supercomputer generation is a configuration called "massively parallel circuits." The system links thousands of memory cells with thousands of small processing computers on a chip. Such a machine could handle thousands of operations at the same instant and untold billions per second, a step beyond what supercomputers can do now. This is where the Japanese are concentrating their efforts.

Meanwhile, back in the Midwest Cray Research appears unfazed by the pressure. "The Japanese got our attention," a Cray spokesman says airily, but "Cray Research is dedicated to one proposition: to continue to provide the fastest, most powerful machines in the world."

"I do tend to look forward in my thinking," says Seymour Cray, "and I don't like to rest on my laurels." He is currently musing about a supercomputer for the Nineties that he hopes will handle *one trillion* operations per second.

How long will it take to count all the atoms in the universe? With new supercomputers like those Cray and the Japanese are working on, a few seconds should do it.

NEW WARES: HARD AND SOFT

As computer components keep getting smaller, companies are mixing them together in ever more versatile combinations. Novation's new Infone, for example, merges several pieces of electronic gear with a modem, a device to connect your computer to another or to a database. The unit also includes a telephone, a full keyboard, a hookup for pay phones, and a 40-character display board—all in a 2.5-pound package smaller than a hardcover novel. Infone is a portable terminal designed for use by business people on the road. It can connect computer to computer or voice to voice through any telephone line, or store information from a database. And it can record voice and text on an optional tape cassette. ($945, from Novation, 18664 Oxnard Street, Tarzana, CA 91356.)

Biomechanist Gideon Ariel, whose digitized models of athletes in action were among the earliest fusions of computing and sport, has created the first complete computerized exercise system: the Ariel. The system looks like a common Nautilus or Cybex multipurpose exercise unit, but a computer controls the weights' speed, force, direction, angle, and many other variables. Digital control makes it possible to preprogram complicated patterns into the weights. The company reports that even the motions of great athletes can be digitized, then used as templates for someone working out on the Ariel. A monitor above the exerciser's head can display menus, performance charts, comparisons with other exercisers, or diagnostic reports on training effects. (Ariel Computerized Exercisers, Inc., 22000 Plan Trabuco Road, Trabuco Canyon, Coto de Caza, CA 92678.)

The 21-inch screen of a new arcade game displays scenes of Dirk the Daring, a valiant knight who is subject to attack by a giant chicken, foot goblins, an acid creature, slime, and geysers, among other nuisances. The scenes have the perspective and color of an animated cartoon feature. But for 50 cents, players change the course of the adventure, moving Dirk around with a joystick and making his sword slash with the push of a button. The secret of the high quality artwork is a computer-controlled laser video-disc system that stores some 50,000 drawings by Don Bluth Animation, which produced the movie *The Secret of NIMH*. The game, called *Dragon's Lair*, can last up to 20 minutes depending on how skilled players are at cheating death. (Don Bluth Animation, 12229 Ventura Boulevard, Studio City, CA 91604.)

EXPLORATIONS

CONTINUED FROM PAGE 110

cavate. Littered among the fossil remains of giant baboons, they found thousands of tear-shaped hand axes, along with choppers scrapers, cleavers and variations in between—all of which are on view at Olorgesailie today. These tools were probably used to dig tubers, pound vegetables, and extract marrow since the bones of the baboons were found smashed But of course that is conjecture

Richard Leakey, whose seven-part BBC television series *The Making Of Mankind* will soon air in the United States, cautions, 'One must always be careful to indicate to your reader or your viewer the transition from what you know to what you think We're not sure about behavior or language, because they don't fossilize What is certain is that there was social cooperation, forming hunting bands, making tools That this required some form of language I think is very likely. It's also quite probable that our immediate hominid ancestors had the sort of life-style that we see in contemporary hunter-gatherer societies.'

North by northwest there are other dig sites, at Lake Turkana at Hyrax Hill near Lake Nakuru and at Kariandusi. At the latter, many of the hand axes are made from obsidian, a black volcanic glass Regarding the behavior of the people who lived at Kariandusi a brochure prepared by the National Museums of Kenya notes, "Fire does not appear to have been used for domestic purposes.

As you explore it is only natural to speculate on how you might have behaved had you lived in those times in these settings Consider the evidence from the excavations read Richard Leakey's *Origins* and Robert Ardrey's classic *African Genesis* and observe the people of Africa who continue to rely on their environment They are attuned to the patterns of plant and animal life and the seasons of few and plenty And they know how to balance them out, now to recognize the call of a certain bird that warns a predator is near, for instance

Buoyed by *Quest for Fire*, which was filmed on location in the Great Rift Valley I like to think of the evolution of the wink. In staring down an opponent, even an animal, the first to blink shows vulnerability Vulnerability equals trust, and today a wink indicates a shared trust, a secret My hypothesis may not be correct, but it's healthy to consider how things began and evolved, and such conjecture is typical of what this journey inspires

The greatest leap of imagination occurs farther north and further back in time at Lake Turkana a diminishing souvenir of the Nile surrounded by a land of raw wind swept beauty. Known as the "jade sea" -because of its algae-rich waters, the lake is overlooked by a group of stone-walled bandas on a cliff, from which you can watch hippopotamuses and crocodiles edge into the whitecaps

The small annex museum at Turkana is exceptional with a life-size re-creation of a hominid campsite complete with model residents Nearby is a complete fossilized elephant and the active digsites of Leakey's "hominid gang," a fleet of fossil hunters employed by the National Museums of Kenya. Turkana is the home of 1470 (Handy Man), and if you go there and don't feel that somehow you too have come home you'll be the first

After Africa, when modern times will seem a little—well—modern you might consider keeping abreast of the past. You can become a member of the Foundation for Research into the Origin of Man (FROM) FROM's *Interim Evidence* newsletter offers updates on discoveries and notices of stateside lectures and the foundation's research-sponsor membership lets you earmark substantial donations for specific projects and receive personal reports from the participating scientists. FROM can also arrange for a behind-the-scenes tour of the Leakey Institute for members who travel to Kenya. For those who prefer still more guidance British Airways, in conjunction with Abercrombie & Kent—tour operators based in Chicago—has designed a safari into prehistory' which features visits to important digsites. The itinerary includes a Richard Leakey-led tour of the Nairobi National Museum, a visit to Olorgesailie and an option to explore the home of 1470, at Koobi Fora Game drives in Amboseli and Masai Mara afford a chance to observe such creatures as the black rhinoceros virtually unchanged for millions of years

If you are a qualified scientist with a valid research proposal approved by the Kenyan government, the Leakey Institute will allow you to study its fossil collection. And should you like a fiberglass reproduction of a fossil for an exhibit a lecture, or simply to keep you company, the department of paleontology will provide a good facsimile of say, 1470 for approximately $100 (postage is not included)

If you can't make it to Africa there are many digsites in the United States and Europe to visit People are digging everywhere—and rightly so As Richard Leakey notes "Our future lies in understanding what sort of animal we are" OMNI

"Is there a word processor in the house?"

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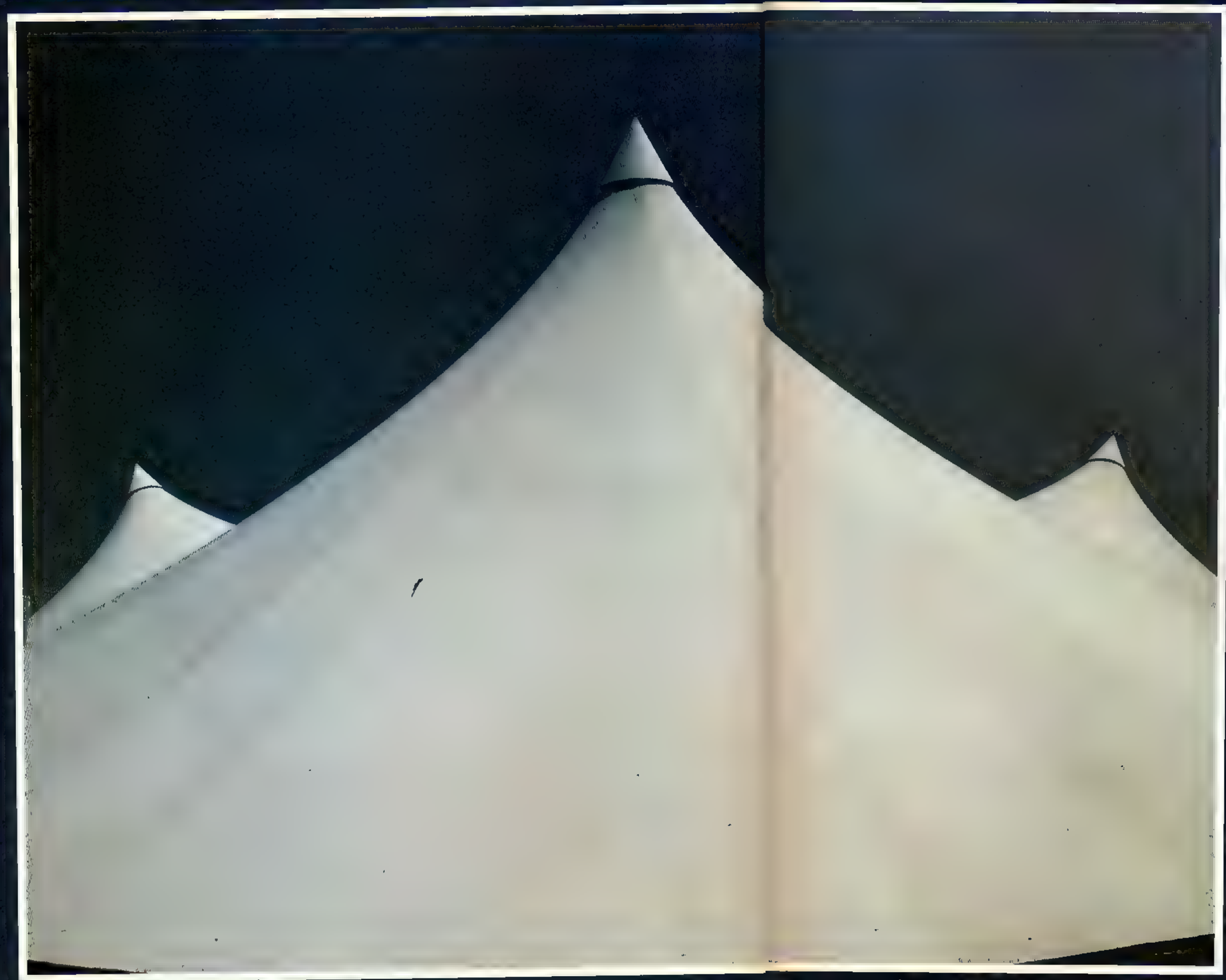


PHENOMENA

Three cones of snow-white fabric jut sharply into the southern California sky above the University of California at Irvine. This unusual configuration is a tension structure, a tripartite building made of special Teflon-coated fabric held in place by tension across its surface. "It's a relative of the pup tent and the umbrella," explains photographer Anthony Wolff, who captured this distinctive view. Supported by three enormous tent poles, the cloth building encloses a student center, a theater, and a gymnasium. Aesthetically soothing to the eyes, the high ceiling and bright fabric give it a light, airy effect inside. And its general shape, determined by computer-aided design, suggests a flowing aerodynamic form, the nose cone of an exotic rocket. Wolff recorded this perspective on Kodachrome 64 film, using a wide-angle lens on his Nikon camera.

E.T.'s IN ANTARCTICA

STARS

By Charles Koltz

Scientific discovery so often involves a marriage of hard work and coincidence. Such a marriage was certainly at work in the case of two meteorites collected from the frozen landscape of Antarctica.

After long odysseys through space from celestial bodies millions of miles apart, the two meteorites landed on Earth a few miles from each other. Now their destinies have intertwined. The two objects are the first meteorite samples that can be positively linked to specific space bodies. One meteorite, it seems, comes from the moon, and the other is suspected to be a piece of Mars.

Both alien rocks were collected during an annual meteorite hunt in Antarctica. There, fallen meteorites lie on the ground in clusters, churned to the surface by glacial action and preserved in near-pristine condition. It was also in Antarctica that, four years ago, a scientific expedition found what is officially designated EETA 79001, a peculiar 17.5-pound grayish-brown rock.

Planetologists usually associate meteorites with comets and asteroids—debris left over from the formation of the solar system 4.6 billion years ago. But radioactive dating showed that EETA 79001 was a comparative adolescent at 1.3 billion years old. The rock appeared to be volcanic and to be formed in a place with an atmosphere. These findings indicated it had come from a planet, not a comet or asteroid. Scientists felt that the exotic visitor was a chip off the Red Planet. "That rock just smells like Mars" is the way University of Minnesota physicist Robert Pepin put it.

Other studies supported that feeling. They showed that some 180 million years ago a violent shock dislodged EETA 79001 from its parent body and drove gases from the surrounding atmosphere into tiny melt pockets of the rock. These gases, when examined by Pepin and others, were strikingly similar to those in the Martian atmosphere.

But there was also good reason for doubt. How could scientists explain the appearance of a piece of Mars on the surface of the earth? Planetologists had long theorized that a meteoroid could smash into the surface of a planet with enough force to scatter pieces of the planet millions of miles off into space. The problem was, they had no evidence that any such thing had actually happened.

And that is where specimen ALHA 81005 comes in. In January 1982 an Antarctic expedition led by geologist William Cassidy, of the University of Pittsburgh, found a piece of greenish-brown breccia (a lump of compacted and scorched soil) weighing 31 grams. Its distinctive color and appearance immediately suggested to the group that they had bagged something special.

Intense scrutiny by 20 different research teams confirmed that suspicion. At Washington University's McDonnell Center for the Space Sciences, in St. Louis, a test for 33 elements pinpointed ALHA 81005's origin as the moon. When he combined his information with that of his colleagues, recalled McDonnell Center Fellow Larry Haskin, there was one group conclusion: "It's virtually unequivocal that this is a piece of lunar rock."

The space rocks have already inspired some cosmic speculation. Laurence Nyquist, of NASA's Planetary and Earth Sciences Division, theorizes that a meteoroid slammed into Mars, simultaneously knocking free chunks of the planet's surface and quickly melting the subsurface permafrost, generating a burst of steam. The combined force of the impact and the burst of steam, suggests Nyquist, could have been enough to propel material into space.

Planetologists have also been speculating about where the moon rock ALHA 81005 could have come from. Larry Haskin, University of New Mexico geologist Richard Klaus, and others think the rock came from the far side of the moon.

What these discoveries have given us is a new technique for doing an Earth-based study of our planetary neighbors. They've also shown that the expeditions to Antarctica have been a bonus for the space program. As NASA astrogeologist Bevan French observes, each find is worth "a free landing mission."

A microscopic view of a meteorite: Finds like this can save us a few trips to space.

The hollow Earth: a maddening theory that can't be disproved

GAMES

By Scot Morris

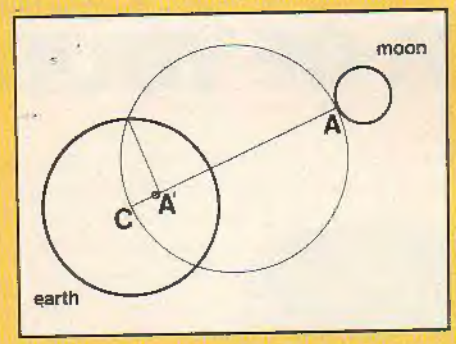
We are sorry to report that Miss Hedwig Michel died a few months ago, at age ninety. For the last 12 years of her life, she was the sole surviving member of one of the most bizarre religious cults of all time, founded over a century ago by a man she never met. When I last talked to her in 1978, she was still a believer.

If there were a hall of fame for pseudoscientists, surely Cyrus Teed would deserve a place of honor. It was shortly after the Civil War that Teed had his vision: The earth is a hollow sphere, and *we live inside it*. Everything else in the universe is in here with us—planets, comets, stars—everything. What's outside the sphere? Nothing.

Teed's cosmology had a particular appeal to religious fundamentalists. It made the earth important again, rather than an insignificant speck in the cosmos. And it eliminated the difficult concepts of infinite space and aimlessly scattered worlds. We're all right here together in this safe, spherical womb.

In 1870 Teed changed his name to *Koresh* (ancient Hebrew for Cyrus) and started a cult. At its peak in the Nineties the Koreshan (pronounced kor-ESH-an) Unity movement had some 4,000 followers. Teed established a religious/scientific community a few miles south of Fort Myers, Florida, and there founded the town of Estero. He was determined to prove his theory scientifically and launched his own geodetic survey in 1897 to do just that. Using his "rectilineator," a set of double-T squares made of large logs, he projected a horizontal line until his calculations indicated that it would plunge into the Gulf of Mexico, four miles from its starting point. This was Teed's proof that the earth's surface is concave and that his rectilineator line had intersected the earth's upward curve.

The scientists had gotten everything backward: It is centrifugal force, not gravity, that keeps our feet planted on the ground. The sphere *is* about 25,000 miles around, just as the scientists say. China is about 8,000 miles away, through the earth's center—straight up.



Top and bottom: Cyrus Teed's models of the hollow Earth. Center: Geometric inversion brings the moon and all other heavenly bodies safely inside the womblike Earth.

The Nazis entertained many occult theories in their quest for world domination, and Teed's was one of them. At one point a Nazi expedition went to the Isle of Man. Its mission: to get secret photographs of the United States by aiming its powerful telescopes *up*.

Koreshanity was a strictly celibate order. Husbands and wives who joined the group thenceforth lived in separate quarters and, of course, brought no bouncing baby Koreshans into the fold.

But Teed was a very persuasive orator. When he died in 1908, his community had over 200 members, most of them female. They were so devoted to him that they kept the group alive through two world wars and continued to recruit new members. Miss Michel joined when she was about fifty, after fleeing her native Germany during the Nazi terrors. At the time there were about 30 members. By 1961 there were only four left, and they turned over the 300-acre settlement of Gulf Coast land to the state of Florida to become Koreshan State Historic Park.

Miss Michel lived on the grounds and told visitors that she still believed. Missile flights and rockets to the moon hadn't changed her mind—all such events were either hoaxes or had occurred inside the shell. Until she died she remained a staunch advocate of one of the most absurd theories ever proposed.

THE WORLD TURNED OUTSIDE-IN

What's most infuriating is that a little mathematical fiddling turns this crazy theory into a proposition that is virtually impossible to refute. The trick is done by *inversion*, a purely geometric transformation that lets a mathematician turn shapes inside-out. When a sphere is inverted, every point outside is mapped to a corresponding point inside, and vice versa.

The geometry is quite simple. If a sphere's center is C and its radius is r, then every outside point P maps to an inside point P' such that $CP \times CP' = r^2$.

In the illustration we show how to project an outer moon (not to scale) to an inner one. Consider A (for Neil Armstrong), the point on the moon's surface that is closest to the earth, which is distance A away from the earth's center. The inner point A' is located on the line such that the product of the two distances CA and CA' equals the earth's radius squared. Here's a good way to visualize it: For any outside point P (on the sun, or Pluto, or Cygnus X, for example), draw a circle that has CP as its diameter. From

one of the two points where this circle intersects the earth, draw a line perpendicular to *CP*. The intersection point is the location of *P'*.

By far the largest celestial body in our inverted Earth is the moon: a bit over half a mile in diameter and some 3,933 miles above our heads. The sun's sphere is only eight feet across. The stars are microscopic spots clustered around the center, which is, of course, infinity.

Is there any way to prove that we *aren't* inside a hollow Earth? We asked H.S.M. Coxeter, mathematics professor at the University of Toronto and an expert on inversion geometry. "I can't think of any," he said. "A rocket flight, an eclipse, a Foucault pendulum, a Coriolis effect—any observation we can make on the outside of the earth has an exact duplicate version inside. There would be no way to tell which was the truth."

Just as the geometry of space inverts, so do all the laws of physics. Toward the center of a hollow Earth, light slows down and everything shrinks—atoms, astronauts, spaceships, and measuring rods. Light travels in circular paths, producing some weird (but lawful) optical effects. Astronauts on the moon looked back on what they thought was a blue sphere in the distance. Actually it was the inside of the earth's shell, through sight lines that flared like the bell of a trumpet, producing the *illusion* of a sphere. The optical distortion is something like the wide-angle view through a fisheye lens.

As we look to the sky and the horizons, our visual field is within a sphere some 4,000 miles in diameter. Celestial bodies that revolve around the earth's center appear to "rise" and "set" as they enter or leave that sphere.

THE THEORY UPDATED

Cyrus Teed said that the moon is an illusion, that gravity is really centrifugal force, and that a horizontal line on the earth's surface eventually intersects the earth's upward curvature. We like to think that if he were alive today he would junk some of his earlier predictions to conform to inversive geometry, thereby keeping his theory irrefutable.

The centrifugal-force idea is demonstrably false. If it were so, there would be two points on the earth's surface where the force disappeared—along the axis of spin. It is gravity of a peculiar kind that pulls us all to the outside. Teed's rectilineator experiment must have been in error. A line that appears horizontal actually curves in toward the center and so gets farther and farther "above" the surface.

Teed would have embraced Einstein's view of a finite, bounded universe in which light travels in circles and eventually returns to its starting point. An infinitely powered telescope aimed straight up, Einstein said, will eventually produce a view of the other side of the earth. That idea might seem paradoxical to most of us, but it would have been intuitively obvious to Cyrus Teed.

Finally, we like to think that Teed would have applauded the space program. We can imagine him driving the 175 miles across Florida, from Estero to Cape Kennedy, to watch the 1969 launch of Armstrong, Aldrin, and Collins to the moon. After all, this would be the farthest in toward Earth's center that anyone had ever gone. A truly historic event.

As if to commemorate Hedwig Michel, the Australian journal *Speculations in Science and Technology* has published an article by Mostafa A. Abdelkader, of Alexandria, Egypt, that considers in all seriousness the proposal that we really *are* in a hollow Earth. Abdelkader says that the only way to test the theory's validity is to drill a tunnel straight through the earth. Until such an experiment is performed, he writes, "it seems . . . that the odds are strongly in favor of [a hollow Earth] being our actual universe."

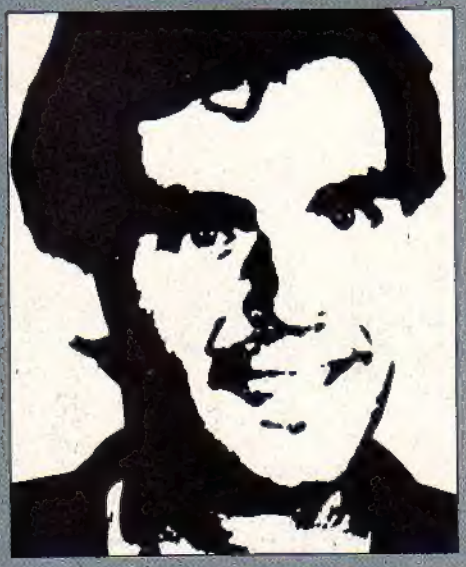
A good introduction to inversion geometry appears in *Geometry Revisited*, by H.S.M. Coxeter and S. L. Greitzer (Mathematical Association of America). Information about Teed and his cult may be obtained by sending a stamped, self-addressed envelope to The Koreshan Unity, Box 97, Estero, FL 33928.

WHAT AM I BID?

Last month we explained the rules of Dollar Auction and asked you to imagine how a typical game might go. Briefly: You offer to sell a dollar to the highest bidder. Bids must be in increments of five cents, and a 30-second time limit is placed on each bid. There is this provision: You will collect from (a) the highest bidder and (b) the second-highest bidder.

Martin Shubik, the Yale economist who invented the game, tells us that "in a typical auction you can sell a dollar for three or four dollars—sometimes even five dollars or more." The game works best in a party setting, with six or more persons. Usually, several people bid at the start, then all but two drop out. Two "aha!" experiences occur along the way. The first is at a bid of about 55 cents, when bidders realize that the auctioneer is going to make more than his dollar. The second occurs close to the dollar mark, as players understand that they are no longer trying to maximize wins but to minimize losses. ("I just heard myself bid a dollar and five cents for a dollar!" said one startled player. "What am I doing?") After this point, the bidding usually slows down drastically—that is, each bid takes close to the 30-second time limit. Also at this point, bidders realize that the auctioneer is not only going to make twice his money but is going to make more than twice his money because both bidders are in so deep they don't know how to get out. Psychiatrists have studied Dollar Auction as a model of such destructive behaviors as addiction and escalation.

There are three strategies, Shubik says. Either collude with another player (for example, stop the bidding at 25 cents and split the proceeds); be the auctioneer; or stay out of the game altogether. Collusion works only if other bidders don't spoil it; auctioneering works only if collusion doesn't. If you want to conduct your own Dollar Auction, we recommend that you do so at a party that is almost over anyway. ∞



LAST WORD

By Nigel ffooks

"Who can join Densa? There is no elaborate examination of an applicant's intelligence like Mensa's. A simple statement of idiocy will suffice."

"Smart? Join Mensa," the ad read. I was sitting in a tepid bath and reading the London *Times*, and I hated the implication that, because I was smart, I should join an organization that seemed to name itself after the Latin word for *table*. Then an idea was born. "Stupid? Join Densa," I spat, and within minutes I was planning details of a new organization to combat intellectual arrogance. Founded on the simple belief that to be bright and to join Mensa is not to be wholly bright, Densa set out to provide the intellectually disadvantaged with a platform from which to proclaim our manifesto.

As a last-ditch effort to secure peace of mind for those who were later to become members of Densa, I telephoned the Mensa offices in England. Explaining how a friend of mine was, by their definition, thick (he had, I told them, an I.Q. of 80 or so), I suggested that perhaps he and I, or even a group, could add together our intelligence quotients and apply for some sort of joint membership. While the person at the other end of the telephone went off to inquire whether they accepted entrants on these terms, I quietly replaced the receiver, my last doubts confirmed.

Although Densa has humble roots, it has now matured. It asserts that societies of people where the criterion for membership is a common attribute very quickly become tokenist pressure groups. For example: "Left-Handed Lesbians Against the Bomb." Does one join such a society because of one's dexterous, sexual, or nuclear proclivity? What if you can satisfy only two of the three criteria?

There is always something sinister about these groups, because the qualifications for members are defined first and the aims thrust upon them only later. Yet, a lot of people need to join societies. This has been borne out by the large number of applications Densa receives from people who have been rejected by Mensa. While they are usually gently accepted into our flock, these failees, coming to us on an emotional rebound from Mensa, are not really the stuff for whom Densa was originally intended.

But leaving aside this inquiry into the sort of people who start societies, what sort of person applies to Densa? We now have members on five continents, but being an intellectual joke of sorts (albeit not of a particularly high caliber), Densa seems to have little appeal to the thick—even less than Mensa has for the bright. Consequently one of the more lighthearted aspects of Densa is that it is full of reasonably intelligent men and women. (A society for the stupid full of intelligent people? What sort of success is that?)

Densa is not universally loved. Some find its posturings unpalatable, even obnoxious. Perhaps those individuals most eligible for membership are those who do not join us, who do not even find us funny! Densa, after all, is not a particularly clever idea, even less so if you have to pay to join.

Who can join Densa? There is no test, no elaborate examination of an applicant's intelligence such as Mensa requires. A simple statement of idiocy will do. Some, however, find the rigors of joining more difficult than others. Witness the man who wrote three times, failing to put his name at the top of his letter each time. He realized his mistake only when he heard himself mentioned on national radio. A welcome member indeed.

Not everyone has been accepted by Densa. Some of the rejection letters probably make nasty breakfast reading for the aspiring idiot, rejected from that one club he was sure he could join—his returned check torn neatly into two pieces and accompanied by a curt dismissal to underscore the fact that even the densest have their pride and it will not be bought at any cost.

On the whole, Densa has succeeded where Mensa has failed. To the best of our knowledge, no one in Mensa has an I.Q. of greater than 200, a figure that some suggest is a tremendous achievement. Quietly members of Densa revel in the attainment of a combined I.Q. of several hundreds of points. In the words of one member, "When we reach a million, then we can start to think."

In the end, is there any point to these societies at all? Reading through the British Mensa Newsletter, one finds it difficult to get very excited by its contents. There are the usual pleas for money one could find in any parish newsletter, and the advertisement columns are filled with suggestions that "Male, thirty, might do well with female, twenty-one, similar interests," whatever they are.

Mensa, nevertheless, remains an enigma to many people. Who are these Mensans, and what do they do? Very few know, but hundreds seem to fear them, or see them as pitiful souls to ridicule. Does Mensa serve any purpose? Does Densa, in opposing it? The answer is probably no in both instances. But becoming a member of Densa and accomplishing something is surely better than becoming a member of Mensa and doing nothing at all. All that can be concluded is that Densa, with fewer members, is a far more select group and, at $15, a good deal cheaper to join. ∞

Nigel ffooks is the founder and guiding light of Densa. If, after reading the above, you still want to join Densa and display your membership pin and certificate of idiocy proudly, write to Densa, 15 Durham Terrace, London W2, England, and enclose a check for $15. Unsuccessful applications will be returned.